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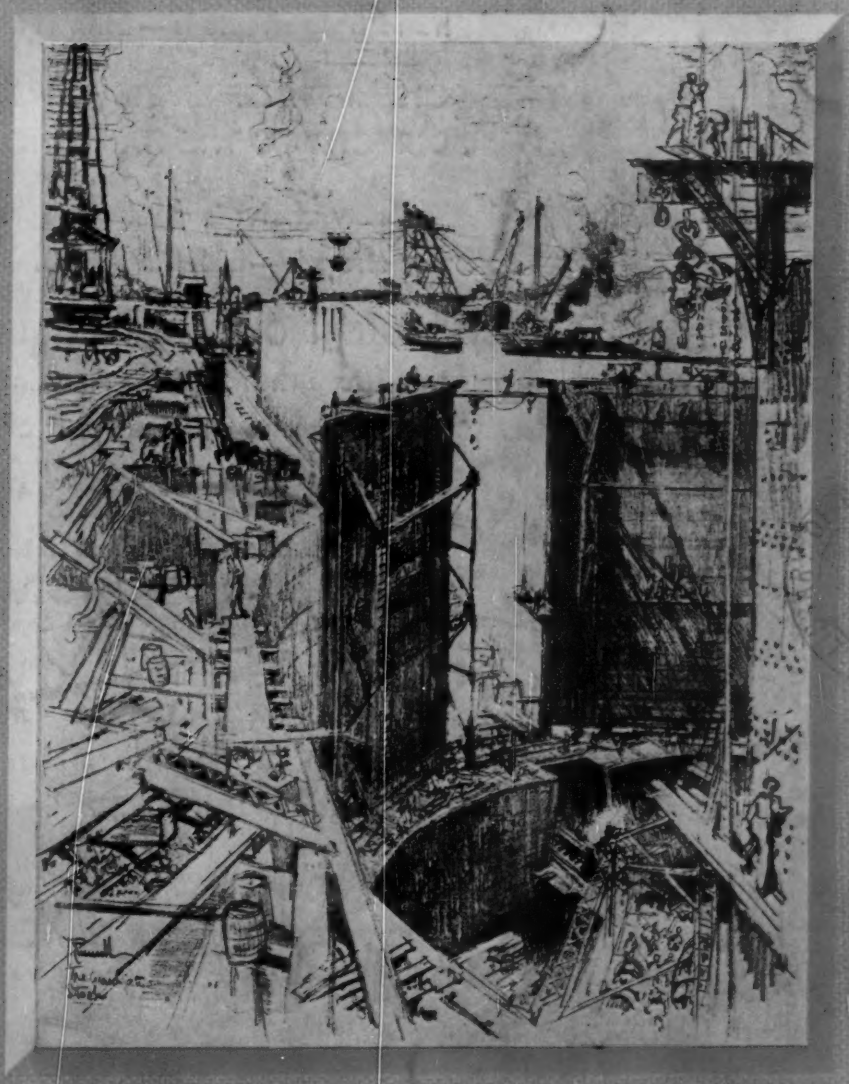

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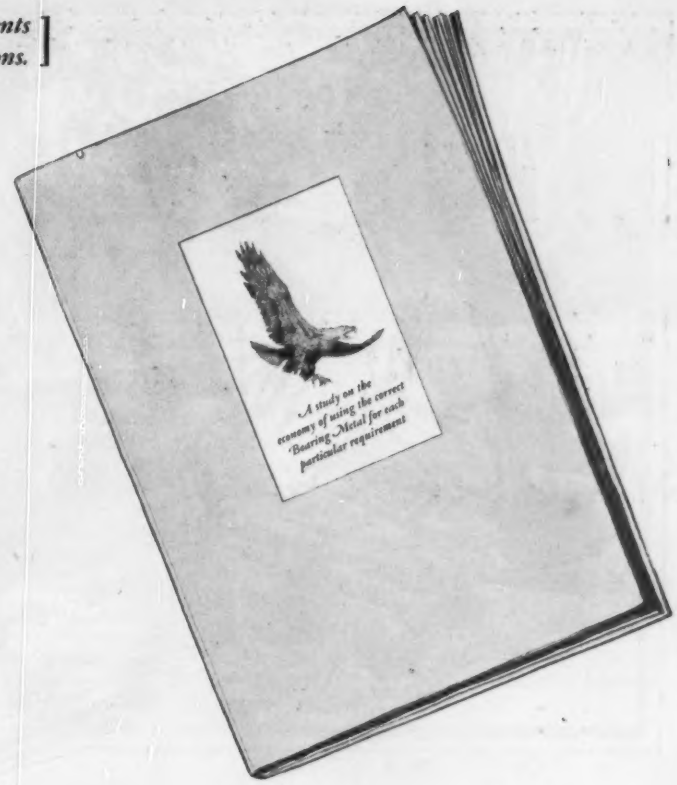

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THE TECH ENGINEERING NEWS

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VOLUME X | OCTOBER, 1929 | NUMBER 5

The National Air Races

Representing the latest developments in aviation, the exposition shows the improvements made during the past year

By JAMES C. REDDIG '29
Engineering Staff
Grover Loening Company, Inc.

COUNTRY-WIDE interest was aroused by the National Air Races and Exposition held this year at Cleveland, Ohio, during the last week of August. Planes representing the Army, Navy, Marine Corps, commercial and private flying united to make the gathering the largest of its kind. Acrobatics, formation work, parachute jumps, air races and other spectacular feats served to hold the attention of the average citizen mildly interested in aviation. The technical sessions of the Society of Automotive Engineers (aeronautical sections) held in conjunction with the races were well attended by engineers from all parts of the country, and were of great importance. Many new developments were seen, and marked improvements during the past year were shown, so that the races may be said to have expressed the true spirit of progress of American aeronautics.

A very impressive note was sounded at Cleveland by the lighter-than-air branches of aviation. Three Goodyear non-rigid dirigibles, blimps similar to the "Mayflower" now assigned to the Institute and stationed at South Dartmouth, Massachusetts, were on hand every day of the meet. The unique all-metal-covered "tin can" dirigible *ZMC-2* (tested, approved and accepted by the Navy, from last reports) visited the field early in the week, landed, refueled and returned to Detroit. The Navy's "Los Angeles" attended the races overnight, being moored to a temporary mast on the field. Her arrival was followed within a few hours by the "Graf Zeppelin" as this big rigid airship hastened to Lakehurst to conclude her great round-the-world flight.

The "landing" of the Vought biplane, flown by Lieutenant Gorton, U.S.N., on a special gear projecting from beneath the belly of the "Los Angeles" was very interesting. Lieutenant Gorton succeeded in hooking to the dirigible only on his third attempt at the hook. He then took a passenger aboard his plane from the "Los Angeles," released himself, and returned to the ground. Many experts consider that this ability to "land" on a zeppelin will be of vital importance in the future development of the lighter-than-air craft, and the Navy is incorporating an airplane hangar in the interior of its new giant dirigibles now being built at Akron.

In considering the airplanes at Cleveland, there is certainly a continued effort to improve performance, which has been noticed for some time. There is no denying that other elements are receiving their due share of attention: safety, comfort, etc., but performance still holds much attention. Perhaps this is to be expected in view of the emphasis which such a meet as the National Air Races places upon the spectacular elements of aviation.

The designers would seem to have devoted less attention to the obvious method of increasing performance, *i.e.*, increasing the size and power of the power plant installation. This was a favorite procedure a few years ago, and now they have turned to making better use of the power on hand by improvements in the airplanes themselves. On all sides the planes have been "cleaned up" wherever possible at the expense of cost and probably weight in many cases. Wings and struts are faired and filleted into fuselages, in-line air cooled engines are becoming popular, N. A. C. A. (National Advisory Council for Aeronautics) type cowlings are being developed for the radial type engines.

Four methods of improving the efficiency of the power plants were noted. Charles W. Meyers flew a Great Lakes biplane in which an N. A. C. A. Roots type supercharger had been mounted on the back of the American-made version of the English "Cirrus" four-cylinder in-line air-cooled engine (Fig. 1). Although this airplane was a special racing project with the front cockpit covered up, streamlines added to the wheels, and other equipment not standard on the commercial model, the introduction of the supercharger in this form is really unusual for a non-military airplane. There is every reason to believe that we shall see more and more supercharged engines. The Great Lakes people themselves appeared to be pleased with the experiment and have been reported as saying that this equipment will soon be obtainable on their commercial airplanes.

A second power plant innovation this year has been of tremendous interest to everyone — the new method of chemi-

FIG. 1
GREAT LAKES SPORT BIPLANE
An N. A. C. A. Roots type supercharger has been mounted behind an American "Cirrus" engine.

cally cooling a water-cooled-type motor. The liquid used is commercial "Prestone," an alcohol called ethylene-glycol, which has a high boiling point of 387° F. By its use, the engine operates at higher temperatures and at greater efficiencies. Formerly the engines could not operate above the boiling point of water that cooled them, a serious limitation on the possible efficiency. Mr. Frank, attached to the Army Air Corps Engineering Division at Wilbur Wright Field, speaking before the S. A. E. on the Army's share in this development, reported an incredible fuel consumption figure of .39 lbs. fuel/ B. H. P./hour under laboratory test conditions, with an engine using this cooling system. There is also the advantage with this system that the casing of the cylinder cooling jackets is at the high temperature of the liquid within, and due to the increased temperature difference between the jackets and the air, the air circulating around the engine does an appreciable share of the cooling itself.

Although there were no controllable-pitch propellers (a propeller, the pitch of whose blades can be varied in flight at the will of the pilot) being flown at the air fields, great enthusiasm was shown at the S. A. E. session dealing with propellers, in this third method of better utilizing available engine power. It is known that many interests in the industry have been working for a long time on a practical propeller of this type; some of these propellers have been pleasingly successful, and there prevails an optimistic attitude that the solution is close at hand. It was suggested that the first practical form of this propeller would be a simple affair which the pilot could set either at a position of "best climb" for use in taking-off and in climbing, or a position of "best speed" to be used in straight flying. Such a device would substitute for an ideal arrangement whereby the blades could be set at any angle whatsoever, or even a device such as the Beacham Hele-Shaw propeller of Great Britain, which would automatically set the blades for best results at any attitude the airplane is put into. There exists no doubt that airplane performances are going to be smartly improved by such a propeller in the near future, for tests with the crude forms thus far developed have shown this to be true.

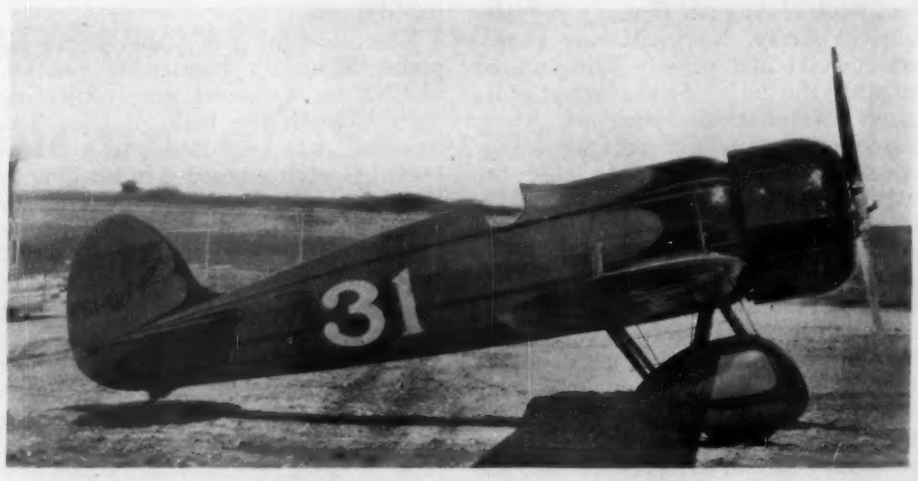
The advantages of the use of reduction gearing between the engine and propeller were outlined as a fourth method of better using available power, due to the increased efficiency of the slow speed propeller, and the increase in engine power, at no serious addition in weight, by high crankshaft speed. Two airplanes illustrated the coming use of this expedient in commercial fields — one, the Curtiss "Condor" transport with geared "Conqueror" engines, and the other, the General Airplanes mail plane with the geared Pratt & Whitney "Hornet."

Improvement of performance by reducing the parasite drag of the various parts of the airplanes has been universally resorted to. Probably the most spectacular example of this was the much-talked-of Travel Air Mystery Racer. (Fig. 2.) This is the airplane with which Douglas Davis outflew the crack ships of the Army and the Navy, in the Free-for-All Races, using an engine of lower power. It was by far the fastest thing at the meet, and is probably the fastest commercial airplane yet flown. One lap of the Free-for-All was flown at an official figure of 208 miles per hour, and the time for the whole race was a fraction over 195 miles per hour, which included an extra turn about a pylon which had been cut too short. This airplane used a Wright J-6 9-cylinder 300 h. p. radial engine, equipped with a typical N. A. C. A. cowling. The picture of the ship covers its main points eloquently. A sister ship with a 6-cylinder in-line air-cooled Chevrolet aircraft engine also put on a very good show, but was unable to surpass the model here shown.

This Mystery Racer serves to illustrate a number of characteristics of design which figured prominently at the races. Despite the fact that the N. A. C. A. engine cowling has been known for some period, very few commercial ships were so equipped. The majority of those seen were special equipment, many experimental at best, and added for racing purposes only. There was a divergence of results obtained; some ships appeared to have been materially improved by the cowling, others very little. Some of the three-engined transport planes were fitted with only the nose engine so cowled, the explanation being offered that due to interference with the flow of air over the wing, the cowling was not beneficial to outboard engine nacelles.

The return to wire-braced monoplane wings smacks of the old war period monoplanes. This Travel Air Racer, the Heath "Baby Bullet," and one commercial sport ship, the new Emsco, used this system of wing bracing. This same practice was universally adopted by the seaplanes in the Schneider Cup Race.

There is an important step in the increasing popularity of the in-line air-cooled engine, particularly in the lower powers. Curtiss showed their new "Crusader," a 150 h. p. six-in-line inverted engine which they propose to use widely on their own models. The "Rover" 4-cylinder in-line inverted was being flown at the field. An interesting 8-cylinder, with two 4-cylinder-in-line opposed banks, was shown for the first time. One of the Travel Air Racers had a 6-cylinder inverted Chevrolet. And the old standbys, the De Haviland "Gypsy" and the "Cirrus," each four-in-line British engines now made in this country, were very numerous. This type engine is usually heavier than any radial equivalent, but the lower head resistance to the airstream and



Courtesy *Travel Air* FIG. 2. THE TRAVEL AIR MYSTERY RACER
This plane, with parasite air resistance reduced to a minimum, won the Free-for-All Race against Army, Navy, and civilian ships.

improved visibility for the pilot seem worth this price of weight.

A great deal of attention has been given to landing gears, notoriously bad in slowing down any airplane. Some airplanes used simply a stream-lined housing of some material held in place around the wheel, as on the Travel Air Racer, and in the little Davis monoplane racer (Fig. 5). General Airplanes have reduced their gear to a single cantilever strut with the wheel on the end of it. The Eaglerock "Bullet" retracts the entire landing gear nearly out of sight into the wing, with apparently good results in increasing speed. We should see more of such mechanisms.

Goodyear engineers showed for the first time a very interesting solution to this landing gear problem. For a standard airplane wheel, say 30 x 5 inches, they substitute a Musselman "Air Wheel" — nothing more than a 22 x 10-inch tire, resembling a huge doughnut, mounted directly on a special hub without spokes. This incredible looking wheel not only saves weight, but has shown a surprising reduction in drag over the standard wheel and tire assembly, for all but the smallest sizes, a claim apparently borne out by Army tests. Unfortunately no provision for wheel brakes has yet been satisfactorily arranged; the effect of these on weight and drag will doubtless be important. The action of airplanes in trying to maneuver on one or more flat tires of this type is not yet wholly certain, so that while the success of the new wheel is not assured, it provides interesting speculation. Several of the racers were equipped with this wheel; it is not, however, out of the experimental stage and widely available.

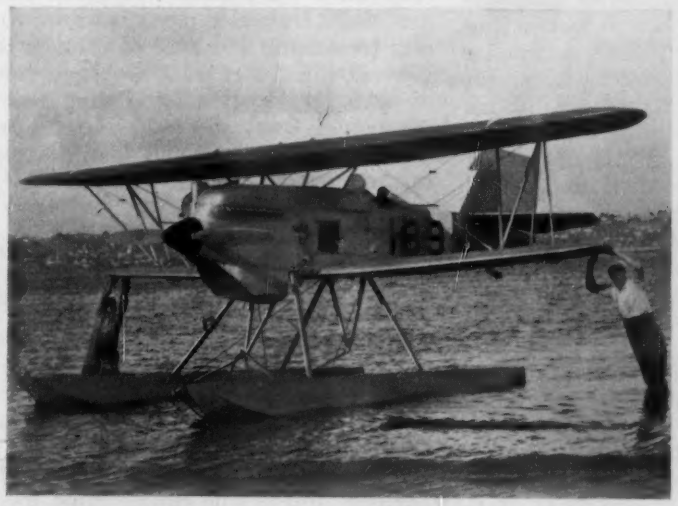
The chemically cooled "wet" engines, referred to above, were represented by an Army and a Navy (Fig. 4) pursuit ship. In addition to the improvement in engine performance as a result of this system, a considerable reduction in the weight of the power plant cooling system is had, and the frontal area of the radiators needed for cooling amount to some one-third of the corresponding water radiator area. The reduction in parasite drag and increase in speed of the plane can be imagined from a comparison of the pictures of the standard water-cooled Hawk and the "Prestone" cooled Hawk as flown at Cleveland (Figs. 3 and 4).

Aside from details, there were no astonishing developments in the aircraft designs as a whole. One of the Autogyros with its four-bladed rotating wing, gave frequent exhibitions of an ability to fly and to land without appreciable rolling from the first spot touched. It is understood that a good-sized craft of this type, having a commodious passenger cabin, is now being built at Philadelphia, and we are undoubtedly to see more of this original type. There were a flock of three-engined airplanes on hand. Mr. Holman gave what was really an astounding exhibition of acrobatics with a huge Ford Trimotor, including loops, a very creditable but brief spin, and inverted flying. On one afternoon, a duplicate exhibition was attempted with a big Fokker, but the ship succeeded in merely demonstrating inherent stability sufficient to drop its nose each time the pilot attempted to pull it up into a loop. There were several small trimotored planes, the Bach, Emsco, and the new Hise, all of the same general plan. General Airplanes exhibited a very significant freight and mail airplane at the Exposition, which had not then been flown. This was a beautiful piece of workmanship, having an all-metal monocoque fuselage and a sesquiplane wing arrangement. The ship was fitted with a geared "Hornet" engine of 550 horsepower — an unusual and promising step ahead in the commercial field.

As another indication of what is coming, the gliders cannot be overlooked. These craft operated under great obstacles on terrain totally unsuited for an exhibition of their peculiar properties, but the interest they aroused cannot be ignored. A few gliders were towed behind airplanes, coming several hundred miles to Cleveland in this manner. This year's races were the first at which this sport was represented in any great degree, and the ships and their youthful following earned the recognition which is being afforded this phase of aviation.

Technology was ably represented at Cleveland. Prof. C. F. Taylor, head of the Department of Aeronautical Engineering, hastened there as he concluded a European tour. Former Professors E. P. Warner and C. H. Chatfield, Instructor M. Rauscher, all of the Institute's staff at one time or another, attended the races. Lieut. "Jimmy" Doolittle made himself famous again by pulling the wings from the Army

(*Continued on page 208*)



Official Photograph U. S. Navy

FIG. 3. STANDARD NAVY CURTISS "HAWK"

This plane is equipped with the Curtiss D-12 engine with water cooling, and the size of the radiator is a considerable disadvantage.

Official Photograph U. S. Navy

FIG. 4. PRESTONE COOLED CURTISS "HAWK"

This plane is also equipped with a Curtiss D-12 engine and has a prestone cooling system. Note the small radiator area with decreased resistance.

FIG. 5. DAVIS SPORT MONOPLANE

A two-place, open cockpit plane, it represents a typical special streamlining job for racing.

Prevention of Mine Accidents*

Some phases of the Government's work in eliminating mine disasters

By J. J. FORBES
Supervising engineer, Instruction Section
U. S. Bureau of Mines.
and
W. J. FENE
Associate mine safety engineer
U. S. Bureau of Mines.

FOR the past twenty-two years the Federal Government has been investigating and making a study of mine disasters in order to disseminate knowledge that would eliminate the occurrence of such disasters. A series of disastrous mine explosions occurring during the year 1907 prompted Congress to authorize an investigation into the cause of mine explosions. An appropriation for such an investigation was made available in May, 1908, and placed in charge of the Technologic Branch of the U. S. Geological Survey. On July 1, 1910, the act of Congress authorizing the establishment of the U. S. Bureau of Mines became effective, and the work previously conducted by the Geological Survey for greater safety in mining was turned over to the Bureau of Mines.

Organization of the Safety Division

The Safety Division of the Bureau of Mines has many activities other than rescue and recovery operations following mine fires and explosions. A personnel of about sixty men operates from eleven mine-safety cars and eleven mine-safety stations strategically located in the United States and Alaska. These stations are at Pittsburgh, Pa.; Berkeley, Calif.; Birmingham, Ala.; Evansville, Ind.; Knoxville, Tenn.; McAlester, Okla.; Norton, Va.; Salt Lake City, Utah; Vincennes, Ind.; Wilkes-Barre, Pa., and Seattle, Wash.

The headquarters for the mine-safety cars are at Pittsburgh, Pa.; Huntington, W. Va.; Pineville, Ky.; Terre Haute, Ind.; Duluth, Minn.; Des Moines, Iowa; Pittsburg, Kans.; Raton, N. M.; Butte, Mont.; Berkeley, Calif., and Anchorage, Alaska.

The personnel of the cars and stations devote their time to instructing men of the mineral and petroleum industries in the principles of first aid to the injured and in mine-rescue methods; they conduct investigations of mine accidents, of explosions, of mine fires, of the use of explosives, electrical equipment, and other safety devices and practices. They conduct field studies of ventilation, haulage, and rock-dusting methods, and especially do they carry directly to the miner and mine management the results of safety investigations conducted by the Bureau and others. They give safety talks before groups of miners and mine operators, such as meetings of the Holmes Safety Chapters, mining institutes, and other safety gatherings.

Three separate and distinct courses of safety instruction are given by the personnel of the safety cars and stations, namely, first aid, mine rescue, and advanced mine rescue and recovery work following mine explosions.

ERECTING A SAFETY BARRIER

Following an explosion this rescue team is building a stopping to direct fresh air through the mines, in an effort to reach those entrapped.

First-Aid Course

Although the first-aid course teaches the worker primarily to take care of himself, it achievesa double purpose, since this knowledge also tends to make him a safer worker. Records of mining companies indicate that in general the frequency of accidents to persons who have been given a thorough course in first aid is less than to those not so trained. As a result of the training given by the Bureau of Mines, numerous incidents are on record where lives have been saved by prompt and efficient first-aid work.

The complete course of first-aid instruction given by the Bureau requires fifteen hours of actual instruction and practice. This is usually given in five periods of three hours each. In brief, the course covers the following: The circulation of the blood through the body and the control of bleeding from arteries, veins, and capillaries; treatment for physical shock; artificial respiration for persons overcome with gas, shock from electricity, and drowning; treatment and care of wounds to prevent infection; treatment and care of burns, dislocations, and simple and compound fractures; and the proper method of handling and transporting injured persons.

Mine-Rescue Course

The mine-rescue course is given primarily to miners and mine officials to enable them to carry on rescue work following mine explosions and fires. All applicants for mine-rescue training must be less than forty-five years of age and must have passed a satisfactory physical examination. In addition to being physically fit, applicants for the mine-rescue course must have had considerable experience in mining and should be capable of leadership in event of emergency. In brief, the course requires five four-hour periods, and it involves lectures and instruction on the construction, use, care, and testing of oxygen breathing apparatus and accessories, and the wearing of the apparatus in irrespirable atmospheres.

Advanced Mine-Rescue Course

The advanced mine-rescue course is given to mine officials and is intended to prepare them in the efficient conduct of recovery operations following mine fires and explosions. The course was inaugurated in 1925 and is the result of a recognized need for instruction of this kind; in time of disaster the local mine organization is usually disrupted, and, as a rule, the officials have little or no idea of the proper procedure to follow, thereby losing valuable time, retarding the recovery work and possibly sacrificing what little chance there may be of saving life. All men eligible for this course must possess a Bureau of Mines certificate covering mine-rescue training. The course requires forty hours of class work, the working of problems

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in rescue procedure underground, and includes study of the following subjects: Mine gases — their properties and physiological effects; methods of protection against and detection of mine gases; and sampling and analyses of mine gases. The classes are given a thorough training in sealing and unsealing mine fires, in organization and procedure, and in actual recovery methods at mines affected by mine fires or explosions.

A course in accident prevention will be inaugurated in the near future, and it is expected that the giving of this course will ultimately occupy the major portion of the time of the personnel of the Safety Division. An intensive campaign is now in progress in which the mining, petroleum and allied industries are being shown how to conduct their own first-aid training in coöperation with the bureau, and it is believed that this will release the personnel now engaged in such work for duty in conducting classes in accident prevention.

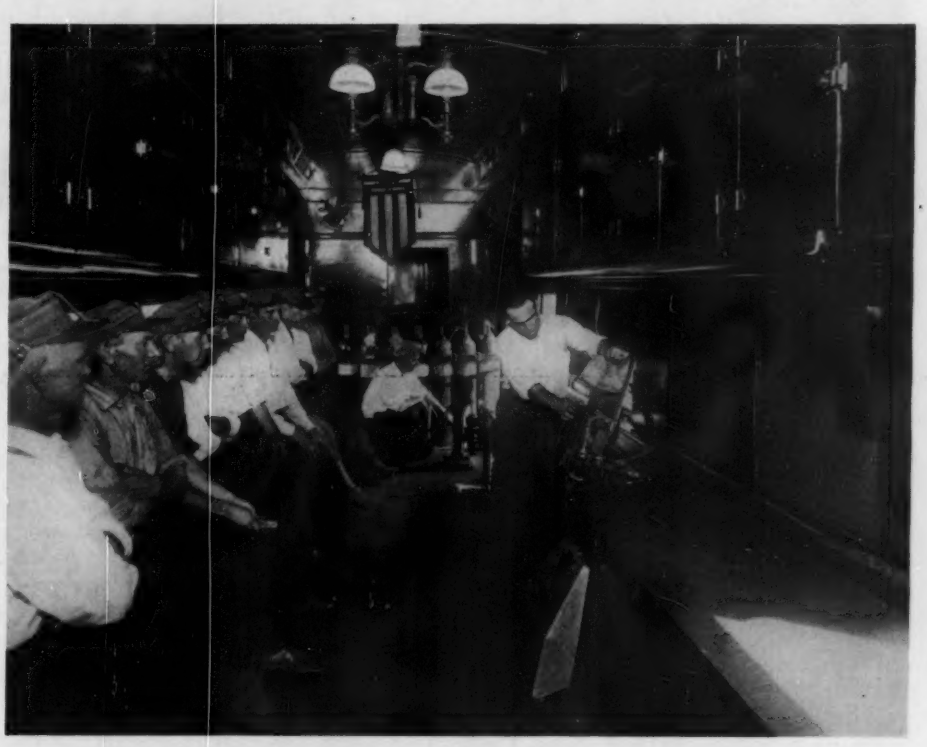
Other Duties of the Safety Division

An important activity of the Safety Division is that of safety inspection of mines or groups of mines. The operating management receives a confidential report of the results of these inspections with remedial recommendations suggesting how to eliminate hazards that may be found. The mine-safety inspection includes a study of practices, conditions, and equipment, and recommendations are made to correct any unsafe conditions found.

The eleven Bureau of Mines safety cars are assigned to particular geographic districts in which they are occupied during the entire year, traveling from one mining area to another and conducting instruction and investigative work. These cars carry a personnel of four men, including an engineer, a foreman miner, a first-aid miner and a cook, and are provided with office, equipment room, sleeping quarters, dining room, and kitchen, hot-water heating furnace, electric-light unit, and some are provided with electric refrigerators. The cars are equipped with self-contained oxygen breathing apparatus, gas masks, resuscitating devices, safety lamps and other gas detectors, which are used for demonstration and instruction and when required are used at disasters.

The eleven Bureau of Mines safety stations are located near centers of large mining districts and are provided with motor trucks which are equipped with a full set of mine-rescue apparatus similar to that carried on the railroad cars. The personnel of some of the stations includes an engineer, a foreman miner, and a first-aid miner who conduct investigations and give instructions in first-aid and mine-rescue methods; some stations have but one man constantly at hand.

Mine operators in general know that the Bureau of Mines will assist them in case of a disaster; in some regions, when a disaster occurs, the bureau is immediately notified, and if needful, the nearest car is rushed to the scene, sometimes by special train. During the disastrous fire at the Hollinger gold mine at Timmins, Ontario, in 1928, in which 46 lives were lost, an appeal was made to the bureau for assistance. In response, one of the bureau cars, manned by a crew of rescue experts, was dispatched to the scene by special train. This special train was given right-of-way along all the route, and a record run was made.



INTERIOR OF BUREAU OF MINES CAR

A group of miners are receiving instruction in the use of oxygen breathing apparatus. In the rear of the car are cylinders of oxygen for use in emergencies.

Training Given to Mine Operators

During its existence the bureau has trained some 300,000 workers in the mineral industries in first-aid methods and some 50,000 in mine-rescue methods. Several thousand more have been trained by State Mining Departments and mine operators. A plan of cooperative first-aid training in which 100 per cent or approximately that number of the employees of plants are trained has been in successful operation for some time. Under this plan a bureau instructor gives a course of intensive training in first aid to a number of selected "key" men of a plant. These men, in turn, and under the supervision of the bureau instructor, conduct and instruct classes of plant employees until all or practically all have been trained. These classes are limited to thirty employees. Approximately 50 per cent of the first-aid training now being given by the bureau is conducted under this plan. Many large progressive mining companies now maintain regularly trained rescue corps and complete equipment of rescue apparatus, and some companies have coöperated and established joint rescue stations. The mine-rescue courses as conducted by the bureau have aimed to reduce to a definite science the whole procedure of handling mine fires, explosions, and the attempted saving of life underground, from the first steps involved in sounding the alarm, summoning expert assistance, and quieting the crowd at the pit mouth, to the bringing forth of the victims. It is difficult to imagine a type of disaster more tragic in its progress and consequences than a mine fire or explosion. Far down in the dark depths of the earth an accumulation of gas or a cloud of coal dust is ignited by an electric spark or perhaps from an open flame. The scent of smoke or the thunderous boom of an explosion sends scores, perhaps hundreds, of men trapped in a maze of subterranean rooms and passageways groping for the avenues of escape, which are only too likely to be blocked by flame, fumes, or wreckage.

The lives of many miners trapped

(*Continued on page 192*)

The New York Port Authority

An interstate agency to develop the facilities of the greatest harbor in the world

By JOHN F. GALVIN
Chairman, the Port of New York Authority

INTERSTATE bridge-building in the New York-New Jersey metropolitan region is the most spectacular undertaking of the Port of New York Authority, yet it is only one of the many activities of this new governmental agency. Organized by treaty between the two States, with Federal sanction, the Port Authority is charged with the duty of coördinating and extending the facilities of the Port District in pursuance of certain fundamental principles.

An important milestone was recently reached in the carrying out of the Port's reorganization program when the Port Authority and all of the trunk line railroads in the Port District were announced as in accord, after long study, on the building of a union freight terminal. Participation in numerous rate proceedings touching the supremacy of the Port of New York; the supplying of information to shippers and others doing business through the port; surveys and inquiries on a variety of matters in coöperation with municipalities in the surrounding areas — these are some of the items on the daily calendar of the Port Authority.

The Port Authority came into existence as a sequel to the New York Harbor Rate Case of 1917 in which the Interstate Commerce Commission declared that the Port of New York was an economic unit, although split in twain politically by man-made State boundary lines, and in which the Interstate Commerce Commission further pointed out the mutual advantages that would obtain by coöperation through a joint or common agency. Four years of careful investigation by a special bi-state commission followed, out of which the Port Authority was born.

The Port Authority, it therefore will be noted, is an agency of New York and New Jersey to which certain responsibilities and duties have been delegated. The agreement under which this agency has been created has the approval of Congress, for Congressional concurrence is indispensable under the compact clause of the Federal Constitution permitting states to enter into such agreements.

In a few short years the Port of New York Authority has made for itself a very creditable record. It has coördinated the separate aims and interests of New York and New Jersey, and worked out plans which have proved to be highly beneficial to both states concerned. Its problems involve the transportation of billions of dollars worth of goods during a single year, and the development of transportation facilities in the great metropolitan area.

States retain control over their own natural advantages and resources, but through the stimulation given the development and extension of those natural advantages and resources, not only their own prosperity but that of the entire nation is enhanced. This is especially true as applying to the Port of New York, upon which the entire country is dependent to an extent that it does not remotely comprehend.

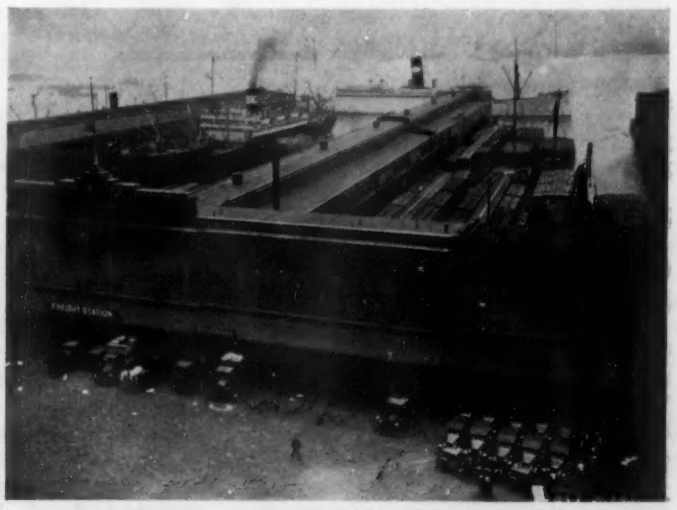
The Port of New York Authority has repeatedly endeavored to arouse the public consciousness to the fact that whatever injures the Port of New York injures the whole nation, that the interests of the Port of New York and of the nation are interlocking.

The problems of the Port of New York are and always will be multifarious and complex, as one would expect in a territory so vast. It is the gateway of the United States and it is the shipping center from which lines radiate all over the world.

A ship arrives or departs from New York harbor every ten minutes during daylight hours. The total volume of shipping engaged in foreign trade touching at this port in one year aggregates 29,000,000 net registered tons, which is about fifty per cent more than the tonnage of Hamburg, the leading port of Europe. The vessels operating in foreign trade carry 25,000,000 tons of cargo in and out of New York every year. Coastwise ships plying between New York and other ports of the United States carry 42,000,000 cargo tons a year.

The Port is served by twelve trunk lines, operating 32,000 miles of main tracks and connecting with all of the 250,000 miles of trackage in the United States. The freight lines of nine of these railroads terminate on the westerly side of the Hudson River, the remainder having stations on the easterly side.

The fast, dependable service of the carriers to and from New York combined with the frequency of steamship



SCENES IN NEW YORK HARBOR
Typical views of some of the facilities for handling the great volume of commodities that pass through the city.

THE OUTERBRIDGE CROSSING BETWEEN NEW JERSEY AND STATEN ISLAND
Now in its second year of operation, it helped to end the island's isolation and speed its growth.

sailings and arrivals permits the maximum possible dispatch in handling exports and imports through this port, with consequent saving to the merchant and manufacturer in interest charges. Where orders must be filled on time, the combined rail and ocean service through the Port of New York offers the best guarantee to both buyer and seller.

In addition to being the gateway to the continent, the port district furnishes in itself an immense local market for high-grade merchandise. The Metropolitan District has a population of approximately 9,000,000 people. In addition to the resident population there is a daily influx of 200,000 visitors who shop in this market.

Not only is the Port of New York a great consuming center, but it also manufactures an amazing variety of industrial products, some of which are exported. The annual industrial output exceeds $10,000,000,000 in value. Great quantities of the total volume of commodities which enter the district, whether raw materials or manufactured goods, find within its limits their ultimate destination. Merchandise imports for the New York Customs District for the year 1927 amounted to 48.9 per cent of the total value of imports for the entire United States; and merchandise exports amounted to 35.5 per cent of the total value of exports of the country.

The Port Authority is constantly striving to maintain this obvious supremacy of the Port of New York and it has taken definite action to bring all other interests of the port district into organized support of this movement.

In time past, the States of New York and New Jersey themselves have been frequently at arms over the development and arrangement of the port. The creation of the Port of New York Authority was undertaken largely to change this condition.

Two bridges, each the greatest of its type in the world, are in course of construction over the waters separating the states. Two other spans linking the two commonwealths are in the second year of operation, with results that already assure their financial success.

Three of these four bridges join Staten Island with New Jersey and end the former's physical isolation from the mainland. The fourth will be a monumental suspension structure over the Hudson River between Fort Lee, New Jersey, and West 179th Street, New York City. It will have a swing from tower to tower of 3,500 feet, or exactly twice that of the Delaware River Bridge between Philadelphia and Camden, which is the present holder of the world's record.

The Kill van Kull Bridge, joining Port Richmond, Staten Island, and Bayonne, New Jersey, will be of arch design and will exceed the one now under construction at Sydney, Australia, by twenty-five feet.

The two completed Arthur Kill bridges, as they are sometimes called, have welded Staten Island and New Jersey. Both span the narrow stream known as the Arthur Kill, the Goethals Bridge joining Elizabeth, New Jersey with Howland Hook, Staten Island, and the Outerbridge Crossing extending between Perth Amboy, New Jersey and Tottenville, Staten Island.

The Goethals Bridge was named after the late General George W. Goethals, builder of the Panama Canal, who was also consulting engineer for the Port of New York Authority. The Outerbridge Crossing was christened after the first chairman of the Port Authority, the Hon. Eugenius H. Outerbridge.

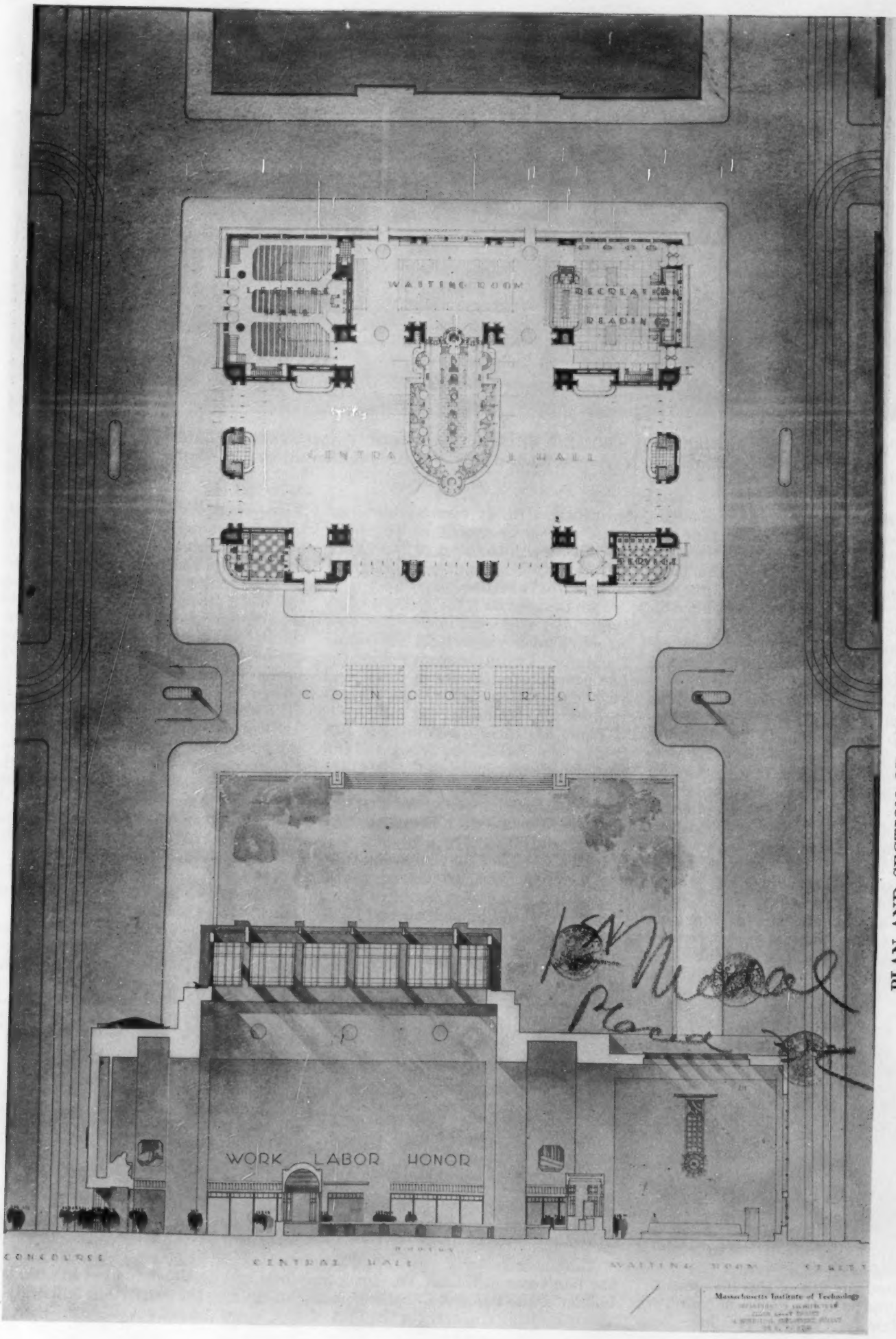
Construction operations on the Hudson River Bridge have been carried to a point where completion can be predicted within the estimated five-year period. The building of the New York anchorage involved the pouring of 110,000 cubic yards of concrete. The steel anchorages for the cables were placed and entirely embedded as the concreting proceeded. On the New Jersey side, the anchorages will be in two tunnels passing 250 feet into the rock. These anchorage tunnels are of such size that they could conveniently accommodate four trolley tracks on each of two levels. The cut through the top of the Palisades for the roadway involved the excavation of 225,000 cubic yards of the hardest kind of rock.

The erection of the towers was started in June, 1928. Such excellent progress was made that within four and one-half months over 30,000 tons of steel were erected and the towers had reached a height of about 500 feet, with 100 feet to go.

The estimated cost, when opened to initial traffic three years hence, is $60,000,000. On the basis of contracts already awarded and real estate that has been purchased, final costs promise to be well within this figure. The Kill van Kull Bridge is estimated to cost $16,000,000 and it also will be ready for public use in 1932.

It is interesting to note in this connection that the Port Authority saved more than $1,000,000 from the authorized and available fund of $18,000,000 in building the two Arthur Kill bridges,

(Continued on page 202)



PLAN AND SECTION OF PRIZE-WINNING DESIGN BY A. E. RIGG

The front elevation appears at the top of the opposite page.

A Municipal Employment Bureau

Third prize in the Beaux Arts Institute of Design Competition is won by a Technology graduate student

THROUGH the courtesy of Prof. H. W. Gardner, Professor of Architectural Design, THE TECH ENGINEERING NEWS is privileged to present one of the outstanding examples of last year's work. The views shown are of "A Municipal Employment Bureau," a design by Alwin E. Rigg, a graduate student in Architecture. It placed third in the competition of the Beaux Arts Institute of Design for the prizes offered by the Municipal Art Society of New York City.

The drawing is a good example of modern architecture, and seems to express the purpose for which the building is intended. In the original statement of the problem the following requirements were made:

"A seaboard city comprising business, manufacturing, shipping, and residential areas, desires to establish a clearing house to connect employers seeking workers with workers seeking jobs. Such a free public employment exchange is to take the place of the fee-charging private agencies and the wastefully expensive newspaper advertisements. At the start, the plan will be limited to men's jobs only, but it is hoped that in time separate offices will be opened to get jobs for women and children.

Since this structure is to house an important public function of the municipality in which it is located, it should be simple but dignified in character and in keeping with the other municipal structures of the city.

The location is to be in the central part of the city, not near to the political influence of the City Hall. A site has been allocated in the business district fronting 200 feet on a small city park and 150 feet on each of two side streets, thus providing suitable waiting space in warm weather. The building should be spacious, attractive, well-lighted and ventilated. Its use will be from 7 a.m. to 5 p.m. and its peak use will be from 7 a.m. to 10 a.m. Into this building will flow several thousand men each day. Each man will have to be registered as to his qualifications and interviewed as to the job that he desires. The calls from employers will be received over telephone wires, although in rare cases employers' representatives will call at the office, particularly in cases where large quantities of workers are sought for. The essence of the work of the employment office will be to connect, with as little delay and friction as possible, the employers and employees."

Four classifications are established for interviewing and registering:

(*a*) Unskilled labor, including farm hands, hotel help, etc.

(*b*) Skilled labor, including mechanics, needle workers, etc.

(*c*) Office workers, including clerks, bookkeepers, teachers, etc.

(*d*) Special cases, such as part-time workers, physically handicapped, etc.

Within the building must be registration booths and desks, a waiting room with a capacity of five hundred men, a combined recreation and reading room, a large statistical office, and an auditorium seating five hundred people, which is to be used for labor meetings.

With these conditions limiting the use and design of the building, the competitors were free to develop their individual ideas as to the particular type of structure best suited to the purpose. Among the many drawings submitted, Mr. Rigg's design was outstanding, and the fact that it was awarded third place by the judges is a high honor, not only to the designer himself, but to the school, Technology, which he represented.

Mr. Rigg came to Technology after graduating from the University of Minnesota, where he attended the School of Architecture. It is interesting to note that the head of the School of Architecture there is Prof. Frederick Mayward Mann, a graduate from Technology in the class of 1894.

The Beaux Arts Institute of Design is an outgrowth of the École des Beaux Arts, in Paris. It was founded in 1902, under the initiative of Lloyd Warren, by Americans who had attended the École des Beaux Arts. This school, founded in 1648, is conducted by the French Government, and is free to men and women. A large part of the students are foreigners, predominately American. The American outgrowth seeks to give instruction in architecture in America under the same plan as that of the Paris institution. The manner of teaching is known as the atelier system. A group of students select a recognized

(*Continued on page 208*)

The Gyroscope*

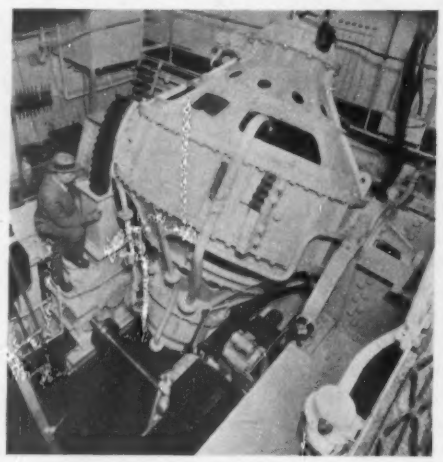
A brief history of this device which is now rendering invaluable service to navigation

By P. R. Bassett
Chief Engineer
Sperry Gyroscope Co., Inc.

IN seeking the beginning of the history of the gyroscope, we must go far beyond the time when the word gyroscope was first used and consider the history of free spinning bodies. A rotating body, if its axis is not rigidly fixed but is free to turn in any direction, exhibits certain properties which have always been considered unusual and even mystifying. The spinning top was the first application of a rotating mass with a free axis. The origin of this toy is lost in antiquity and many different types of tops have been used by various peoples. The fascination of this toy lies in its persistency in defying gravity by standing up on its point when spinning. Tops have come down through the centuries without ever losing any of their popularity and even now they are one of the favorite toys of children in the endless variety of forms in which they can now be obtained. Unfortunately, the gyroscopic phenomena exhibited by spinning tops are not simple, but are a complicated combination of several simple elements, which we will discuss separately.

Another toy which utilizes the rotation of a mass with free axis is the peculiar device called the diabolo. The diabolo is a symmetrical mass consisting of either two cylinders or two cones connected together by a small neck and spun by manipulating a string under this neck. The origin of this peculiar device is Chinese. It seems that the fishmongers of China first used this principle as a method of announcing their approach through the narrow Chinese streets. Their diabolos consisted of two rather large cylinders joined together with holes in the periphery which caused the cylinders to sing with a weird hum and this singing diabolo was the cry of the fishmonger, just as in this country the peanut vender has adopted his shrill whistle.

The diabolo was brought from China to England and France by missionaries as long ago as the Seventeenth Century, and during the gala days of the French Court, when their most arduous task was to amuse themselves, the diabolo became a veritable rage and all the lords and the ladies played with this unusual toy. The diabolo exhibits a simpler gyro property. It will be noticed that when it is spinning on the string, instead of being an awkward behaving piece it settles down into a well-behaved spinning mass, holding its axis of its own accord rigidly in one direction. This property of holding its axis fixed in direction when spinning is so strong that it can be thrown to a height of forty to fifty feet by jerking the string tight, and then caught again, spinning on the string, but during all of the tossing and catching its axis remains pointed in the same direction. This toy demonstrates the first and most important principle of a free rotating mass or gyroscope. We call this property fixity of plane. Newton's first law of motion is, that a mass, if undisturbed, tends to continue in its same state of motion indefinitely. With a gyroscope or rotating mass, the equivalent law is, that if undisturbed it will maintain the direction of its axis fixed in space indefinitely. It is, of course, this same property of fixity of plane which keeps the axis of the earth pointing so steadfastly at the North Star as the earth rotates.



TYPICAL MARINE GYRO INSTALLATION

It is interesting to note that this device controlling the motion of a 2200-ton yacht, itself weighs only 22 tons.

There is a second important property of the gyroscope which is called precession. It is this property which has contributed largely to the reputation of the gyroscope for uncanny and unnatural behavior and which has mystified people the most. Precession, however, may be considered the equivalent of Newton's second law of motion to rotating masses. It is the term for what happens to a rotating mass when it is disturbed or when a force is exerted about any of its axes. Newton's second law states that when a force is exerted against a mass, it no longer remains in its uniform state, but is accelerated. With precession, when a force is exerted on a rotating mass which tries to change its fixity of plane, the mass precesses. The peculiar part of this precession is that it manifests itself in a way quite surprising to us, who are more used to the response of non-rotating masses. If we push or exert a force on any non-rotating mass, it merely accelerates or yields in the direction that we push it. If we do the same thing to a rotating mass or gyroscope, it does not yield in the direction that we push it; in fact, it resists this push but yields or turns on its axis in a direction at right angles to the push. It is this peculiarity of the gyroscope, of having any force exerted about it appear as a force or motion at right angles to the direction that was exerted, that creates the mystery.

During the time that the gyroscope was a toy of children and lords and ladies, the mathematicians adopted this plaything as their own toy and many scientific papers and even books were published on the mathematics of the spinning top. There is no doubt the mathematicians had as much fun with the toy as the children and you will be interested in finding that even as late as the 1911 edition of the Encyclopedia Britannica the article on gyroscopes consists of about eight pages of mathematical formulae on tops and spinning bodies with scarcely a word on any practical application of this device.

Among these mathematicians was the famous and versatile French physicist, Leon Foucault, who may be called the father of the modern gyroscope. You will recall that it was Foucault who first demonstrated the rotation of the earth by an earth-contained experiment. Previous demonstrations all depended on celestial observations, but Foucault in 1851 first demonstrated his ingenious pendulum experiment in the Pantheon in Paris. By swinging a long pendulum from the top of the dome of the Pantheon he proved that the plane of swing of the pendulum slowly changed with respect to the Pantheon. This change was due to the rotation of the earth carrying the Pantheon around with it, whereas the plane of swing of the pendulum remained unchanged. The rate of apparent change was exactly what it should be for a pendulum

(*Continued on page 194*)

* This article was originally presented before the Brooklyn Engineer's Club and appears in its proceedings.

The Seminole Oil Field

The record development of one of the country's most famous fields

By HORACE T. MANN '08
Associate Professor of Petroleum Engineering
Massachusetts Institute of Technology

AN OIL CAMP
Structures such as these are provided by the companies for their workmen.

DURING the years 1924 and 1925 the oil-producing industry was fairly prosperous. In a measure it had recovered from one of its many overproduction sprees. Prices of crude were fair, labor conditions were improving; in fact, the general outlook was considered good.

Early in 1926 the Independent Oil and Gas Company and R. F. Garland started a well in Seminole County, Oklahoma. Producers paid no more attention to this well than to any other wildcat. It was just another well for the scouts to watch and to keep their companies informed regarding its depth and the formations penetrated.

All this was changed when, on July 16, 1926, this first well encountered the Wilcox sand at a depth of about 4,200 feet from the surface. As soon as the necessary tanks and gasoline plant could be erected to take care of the production, a test was made which showed that the well was producing 7,000 barrels of oil having a gravity of 40° Bé. In addition to the oil, as high as 22,000 gallons of gasoline were extracted from the gas per day. The value of the daily production from this well was at that time approximately $20,000.

Almost overnight seeming indolence had broken forth into teeming industry. Oil companies holding leases in the locality immediately made preparations to drill wells; companies and individuals without leases rushed to secure them either blindly or with geological advice. Prices of leases and royalties soared at an enormous rate; bonuses for leases increased in a short time from $10 per acre to $500 and $1,000. Later in the life of the field some leases sold for prices several times the last figure.

In the course of a few months several hundred wells were being drilled. Approximately 350,000 pounds of material had to be moved to each well location under the most trying conditions. A few of the roads had been graded, two were even graveled, but the remainder of the hauling was over country lanes or through fields.

Unfortunately, during this onrush of development, Oklahoma experienced one of the rainiest seasons in her history, making transportation a battle with a bottomless mass of mud. The combination of heavy trucks, dirt roads and constant rain produced a condition which can scarcely be visualized by a person who travels only paved roads.

Professor Mann, from his personal experience, is well qualified to give an account of the opening of the Seminole field. He made an inspection trip to the territory in November of 1926, when the work was in full swing, and visited the field again in the summer of 1927. At the time of his first visit, it was thought that the field might possibly reach a production of 100,000 barrels per day. Some time later a peak production of over 500,000 barrels was actually obtained.

Water supplies for both boilers and drilling wells had to be obtained, which necessitated the laying of a large number of water lines and the erection of pumping stations. Since the companies preferred to install their own water plants, there were a great number of small systems instead of one large central plant.

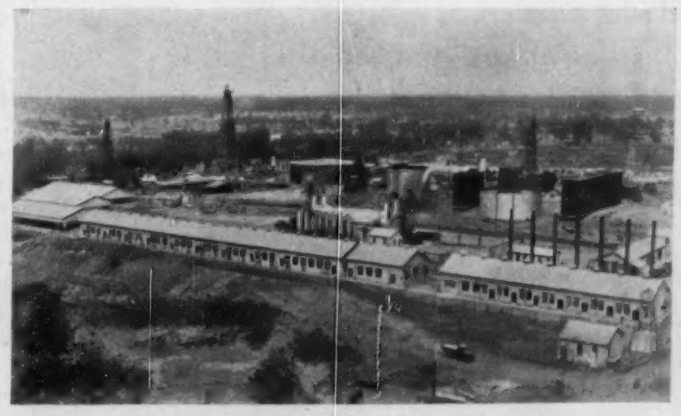
As the wells came in, it was necessary to dispose of their products. This required loading racks at the nearest railroad, pipe lines, storage tanks and gasoline plants for extracting the gasoline from the gas produced with the oil.

ROADS AT SEMINOLE
The heavy traffic continued throughout the development of the field, regardless of weather conditions.

The oil pipe lines were quickly installed; gathering lines were laid from the wells to the main line which, in turn, connected with the transportation companies' trunk line at the nearest point. These lines had a combined capacity in excess of 300,000 barrels per day. Each line had its own pumping stations, the installation of which was no small undertaking. In order that these lines could transport oil efficiently, telephone lines had to be installed.

Some producers, for one reason or another, preferred to store their oil. This was usually done in either 55,000 or 80,000 barrel steel tanks. In a few months, storage tanks in excess of 21,000,000 barrels capacity were available. This tankage required the moving of 70,000 tons of steel into the field and its erection, to say nothing of the preparation of the ground for the tanks, the laying of pipe lines and the installation of pumping plants to bring the oil from the wells to the tank farm.

The gas produced at Seminole was and is rich in gasoline. To extract this gasoline, plants, having a combined capacity in excess of 750,000 gallons of gasoline daily, were erected and put in operation.



A NATURAL GASOLINE PLANT
Gas from wells is converted into an appreciable fraction of our gasoline supply by the use of compression methods.

As the gas pressure in the oil bearing formation declined, it was necessary to pump the oil out of the wells. The air or gas lift was installed on a majority of the wells for this purpose at a cost of approximately $10,000 each. There were several reasons for this. First, there was a large volume of fluid to be handled (2,000 to 3,000 barrels per day), the wells were deep, about 4,200

(*Continued on page 210*)

THE ENGINEER

BY R. DE WITT JORDAN

I am an Engineer —
A humble worker in material things,
An inspired builder,
A high priest before the Altar of Progress.

My slide rule is my baton,
And I count musicians among the creeping waters
Of mighty streams, the forces of the air and earth.
I compose my symphonies in concrete and steel —
My lyrics in the hum of cable spans.

My beacon is a torch of hope
Kindled with a faith in myself and my fellow men.
Through time eternal it has come to me, never flickering.
May I strive to hand it on undimmed.

Under the swirling heat of the desert,
Up where the snow lies deep on mountain crests,
Down where the trickle of water drums against the caisson floor
I dream — yet unlike dreamers, build my dreams.

I labor that other souls, yet unborn,
May tread the earth,
Or sail the wastes of air and sea unafraid.
Mine is the hand which sets countless wheels in motion,
Spans mighty chasms,
Throws down the gauntlet before the elements,
I am an Engineer.

— Courtesy *Wisconsin Engineer*.

Editorials

WELCOME, '33!

At the beginning of school, it seems to be the custom to devote a considerable amount of energy, more or less well-spent, to welcoming the incoming freshman class. Although now in the third week of school, THE TECH ENGINEERING NEWS takes advantage of this, its first opportunity, to extend a hand of greeting to the new men.

We are glad to have them with us, for they are kindred spirits, interested in the fields of science and its engineering applications even as we ourselves are interested. They have chosen a more difficult road to follow in search of higher education than that which is found in a liberal arts college. Already, probably, they have caught something of that feeling which binds engineers together in a common cause and promotes understanding and appreciation of each other's contribution to the general welfare. As time goes on, they will realize more of the opportunities which are open to them to work for constant improvement in our manner of life.

Then, too, we congratulate them upon their choice of M. I. T., and their success in evading the manifold pitfalls which bar the way through the Admissions Office. We believe that they have come to the finest engineering school in the country, and that they are worthy to be students of so renowned an institution. They have been Tech men but a few short weeks, and yet, already they carry their slide rules with a familiar air, and already they have acquired that consciousness of their profession of which engineers are so proud.

Men of 1933, years of golden promise are yours. Here, in the most advantageous surroundings, you have the opportunity to become skilled in the fundamentals of your chosen field. The faculty, the equipment and the buildings, the traditions and atmosphere of M. I. T., all are yours. May you make the most of them!

LIGHT'S GOLDEN JUBILEE

Fifty years ago this month, Thomas A. Edison, aided by a staff of associates, brought into existence the incandescent lamp. The lamp was somewhat crude, judged by modern standards — its filament was carbonized cotton thread, instead of tungsten, and the bulb was exhausted almost to a perfect vacuum, instead of being filled with some inert gas — but it was fundamentally sound. It cost Edison $40,000 in money and unmeasurable effort.

Although it was a triumph in itself to have invented an electric light that would work, yet remained to Edison the triumph of seeing his light become economically indispensable — and a large part of this due to his own efforts. The "subdivision of the electric light" was frankly declared impossible by the leading scientists and electricians of the day. This term meant, at the time, making the electric light commercially practicable as a substitute for gas.

Edison and his associates accordingly turned their attention to problems of power sources and distribution. Dynamos of that day were very inefficient; Edison doubled their efficiency. The three-wire system, in universal use today, was his answer to distribution problems.

To few inventors is the opportunity given of seeing the full usefulness of their inventions. Edison lives today to see his incandescent lamp so indispensable a part of our civilization that its removal would seriously cripple *it*.

At Dearborn, Michigan, Henry Ford has the foundation of a perpetual tribute to Edison. The original buildings in which Edison did his work on the electric light and the original equipment have been transplanted there from Menlo Park, New Jersey. On October 21, the exact fiftieth anniversary of his successful experiment, Edison will re-enact the experiment whose consequences have been so great.

THE COVER

Our cover for the October issue is taken from a number of etchings made by Joseph Pennell during the construction of the Panama Canal. The title of this particular picture is "The Guard Gate, Gatun." This is a safety gate, constructed in each lock to protect, in case of accident, the main lock gate. The size of the engines and figures will convey some idea of the immensity of the undertaking.

PROFESSOR WILLIAM H. WALKER

Among the non-resident members of the Institute Faculty, men who are known to the average student only by reputation, Professor Walker of the Department of Chemical Engineering holds an important place. For many years he was directly connected with the work of the department, and during that time he made many important contributions to the growth of the Institute as a whole and the course in chemical engineering in particular.

His professional career began with his graduation from Pennsylvania State College in 1890. Two years later he received a Ph.D. from Göttingen, in Germany, and then came to Technology for several years as an instructor in analytical chemistry. In about 1895, he left to form, with Arthur D. Little, the firm of Little & Walker, engaging in consultation work in chemical engineering.

After a number of years in this field, he returned to the Institute in 1903 as Professor of Industrial Chemistry. Since the establishment of the course in chemical engineering in 1888, the aim had been to train students in mechanical engineering, with a certain acquaintance with chemistry. In 1904 Professor Walker changed Course X to meet the demands of industry for men trained in the fundamentals of chemistry, with an engineering point of view. The new program, finally completed three years later, met with great success, and when, in 1924, the American Institute of Chemical Engineers adopted certain standards for chemical engineering education, they virtually embodied the principles established by Professor Walker two decades before. The reputation of the Institute has been founded, among other things, on its remarkable initiative in the field of engineering education, and in Course X, the method of training was systematized into an effective technique.

In 1907, under his direction, the Research Laboratory of Applied Chemistry was founded. Today it is well established and employs about thirty-five investigators, but in the earlier years there were many difficulties which Professor Walker had to overcome. In the past twenty-five years it has done more work in the field of corrosion than any other organization in the world, and Professors Wilson, Whitman, Russell and Forrest have carried on the work until now the electrolytic theory of corrosion is universally accepted.

At the suggestion, and with the support of Arthur D. Little, Professor Walker established the School of Chemical Engineering Practice in 1916.

On the entrance of the United States into the war, he was commissioned a colonel and placed in charge of the manufacture of all toxic chemical warfare agents for use by the American Army. The story of the building and operation of Edgewood Arsenal is one with which most Tech men are familiar. On land that was a mosquito-infested swamp in 1917, Colonel Walker erected a huge plant which, at the time of the Armistice, was producing fifty tons of mustard per week, as well as large quantities of chlorine, phosgene and chlorpicrin. The Distinguished Service Medal was awarded as a recognition of his efforts at this time.

After his return to the Institute, President Maclaurin appointed him to organize and head the Division of Industrial Coöperation and Research. Until 1921 he was one of the most active members of the faculty, when he withdrew to take up consulting practice, particularly in the petroleum industry. Professor Walker is noted for his amazing vitality, his interest, and his enthusiasm. A born teacher, he aroused the interest of his students and was to them a constant source of inspiration. He still, in a non-resident capacity, maintains his connections with the Department of Chemical Engineering, where his influence is still strongly felt.

The Engineering Field

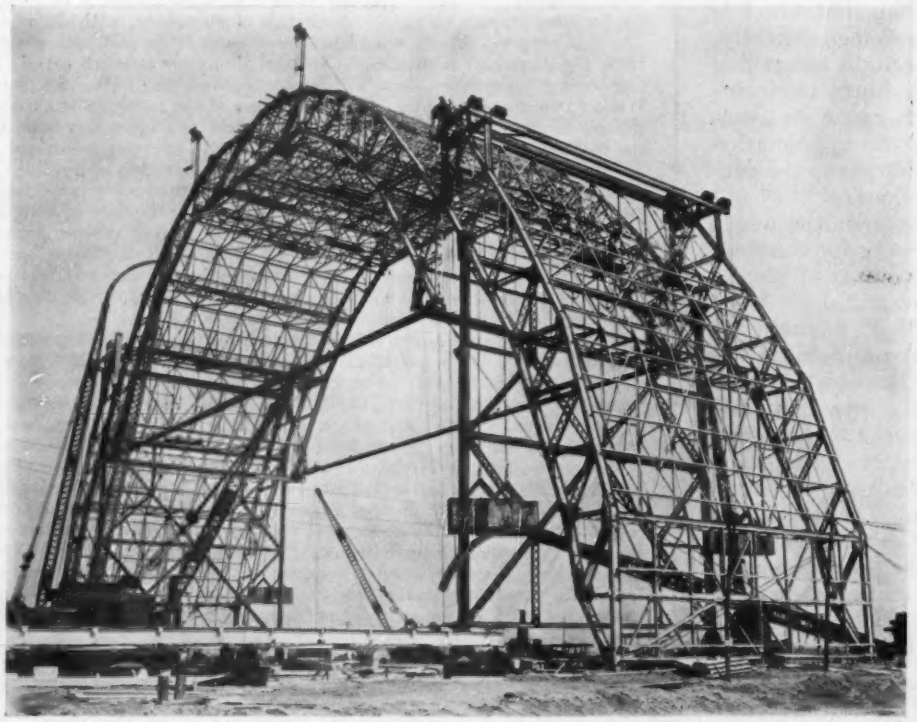
Abstracts from the leading professional and trade journals

A Fast Fighting Tank has recently been brought out which astonished many military experts. Over soft plowed ground this "battle cruiser" made 42 miles an hour, and with its treads removed it made a speed of 62 miles an hour on a concrete highway. The removal or application of the treads can be effected in 14 minutes. Powered by a single Liberty motor and carrying a crew of three men, this tank is believed to be sturdily designed and capable of long service, although endurance tests have not yet been performed.

The Huge Zeppelin Hangar being built at Akron, Ohio, is presenting many varied technical problems of interest to many types of engineers. The building, which has no pillars or inside supports, is to be 211 feet high, 1,175 feet long, and 325 feet wide, covering an area of eight and one-half acres, or four city blocks.

The most spectacular feat of engineering was carried out in raising the central arch of steel webwork into position. After the two 100-foot high side members had been erected, the problem was to raise the remaining portion of the semi-elliptical arch to rest on the side members. This span, weighing 360 tons and measuring 100 feet in height and 200 in width, was assembled on the ground. The ends were then connected by cables and pulleys to eight counterweights hanging under the side members, which reduced the weight to be lifted to 72 tons. Then four railroad cranes with lengthened beams curved at the upper ends were placed so that one occupied each corner of the span, and by the aid of the counterweights the 360-ton span was placed into position, as in above picture.

Twelve more of these arches have to be erected, resting on rollers on the concrete piling to take care of the one-foot expansion of the length of the hangar. The surrounding land is nearly level, and rolled fill of five-foot depth was placed to make a better surface. The concrete work, all reinforced, involves some 12,000 cubic yards of concrete. The floor is to be perfectly level for it is to be used as a fixed plane in making measurements in airship construction. The "orange peel" doors, covered with corrugated steel, as is the rest of the hangar, weigh 750 tons apiece, and by means of electric motors and hydraulic brakes either end can be opened or closed in five minutes. Besides numerous workshops, the space can house a zeppelin of 10,000,000 cubic feet gas capacity — more than twice the size of any existing ship.



RAISING 360-TON ARCH OF AKRON, OHIO, HANGAR
Note the counterweights which assist the raising.

The Huge Lloyd Dam in India, the largest in the world, costing $6,300,000 to build and fifteen years to construct, is more interesting as one of a series of projects than as a construction achievement.

The dam is 5,333 feet long and 190 feet high above lowest foundations, creating an artificial lake of 24,198 million cubic feet, or 14½ square miles, and 60 feet deep. Eighty-one gates, of which 45 are automatic, regulate the water level of the reservoir. The hydro-electric power, which would amount to 1,200 h. p., is not used at present. The economic demand for this great 21,500,000 cubic feet of masonry is of utmost importance in supplying the Bombay district with irrigation. The cost of the whole project works out at about $103 per acre to be irrigated, while the annual gross value per acre of crops amounts to $59.

The First Metal-clad Dirigible, the *ZMC–2*, built in Detroit for the United States Navy, has just successfully completed its test flights. The dirigible consists of a metal hull of thin aluminum alloy sheet in which are inclosed two ballonets of two-ply rubberized fabric, and the control car with two 220 h. p. air-cooled engines supported on outriggers. The *ZMC-2* carries its lifting gas within the hull itself, the ballonets being inflated with air to regulate the gas pressure. In previous dirigibles the ballonets carried the lifting gas. The capacity of the hull is 202,200 cubic feet.

The dirigible's framework consists of 24 longitudinals of single rolled channel section, and five main transverse circular frames of built-up triangular section, all stamped out for lightness. To assist in retaining the craft's shape, seven smaller frames supplement the main five which carry almost all of the tensile strength. The two rear main transverse members support the ship's fins which are placed 30 feet forward of the tail. The control car, located amidships, is attached to the central main transverse rings, while the fifth main ring takes care of nose stresses.

All the framework of the dirigible is of duralumin, the thickness of the longitudinals varying from 0.014 inches to 0.32 inches. All of the fins and control surfaces as well as the control car covering are constructed of corrugated duralumin, while the hull is covered with uncorrugated aluminum alloy

skin, having a gage of 0.0095 inches.

It is thus anticipated that all-metal construction in airships of larger size will not increase the weight as compared with fabric construction. Complete, the empty weight of the *ZMC–2* is 8,800 pounds.

An Automatic Riveting Machine of unusual interest was necessarily developed to complete the work on the metal-clad dirigible *ZMC–2*, whose hull was girdled with metal plating cut in strips from 6 inches to 17¾ inches wide.

The riveting machine is capable of spacing, inserting, and completing 135 rivets per minute. It is set on a carriage, mounted on concentric rails placed directly under each half of the hull. The machine is then adjusted to the proper angle of the hull plating, a gaging device giving a correct and uniform overlap of the plates which run half the length of the ship. In the machine's operation three strands of wire, size 0.035, were fed like thread into the machine, and three rows of rivets were sewed simultaneously. The machine was hoisted toward the hangar roof as the work progressed.

This new machine is very speedy and reliable in operation, eliminating all danger of tearing the delicately fine metal fabric of the hull while sewing the pieces together, which machines of the older type would never guarantee.

A Nibbling Machine, a new development, is an automatic device which is being used extensively in aircraft factories. This machine is very simple in its operation, consisting simply of a circular die above which a cutting punch operates at high speed and cuts metals or sheets along an inscribed line or to a template.

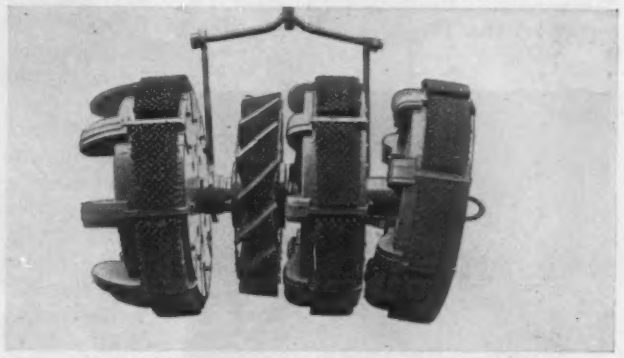
The outstanding feature of this nibbling machine is the fact that the cutting operation does not distort the material being cut, and therefore does not cause invisible fractures which might result in a complete failure of the part at some later time. The machine results in saving of labor and costs.

Gas in Steel may be boiled out to leave a brilliant lasting sheen instead of a dull, rusty surface. This is being done at present in a large glass, high frequency, induction vacuum furnace. A high vacuum draws off the gases that boil out, and the furnace glows with a brilliant soft blue light, believed to be the same in character as the Aurora Borealis. The furnace quickly melts the hardest steels but does not burn the hand. The iron obtained by this treatment is better for making magnets than ordinary iron and may find wide applications in the electrical industry.

Whalebone Pipe-cleaning Brushes are being used in England to clean water conduits by removing incrustation caused by "water bacteria." The brush moves in the direction of the skids on the leading element, being driven by the pressure of the water behind it. The flow of the water is regulated by opening sluice outlets on the main line in front of the brush.

The joint in the shaft of the brush permits a movement of 15 degrees of the leading and trailing brush elements. The paddle, between the leading and the middle brushes, revolves on the shaft and actuates a clapper which locates the brush when in operation. The length of the brush is 5¾ feet and its diameter 42½ inches, its total weight being 1,261 pounds.

This pipe cleaner, among other recent developments, shows clearly that Great Britain is ahead of the United States in water-pipe practice.



WHALEBONE PIPE CLEANER
The flexibility of the cleaner is clearly shown.

A Six-Wheel Truck with power transmitted to the road through the front and first pair of rear wheels has recently been developed for unusually rough service over poor roads. This is, in effect, the well-known front wheel drive truck, with an added pair of load carrying wheels. It has a rated capacity of 6 tons and a chassis weight of 9,500 pounds, its six-cylinder motor developing 87 h. p. at 2,500 r. p. m.

The motor and transmission are designed after the older model, the main change being in the suspension of the two rear axles. Two semi-elliptic springs are employed on each side of the frame, both being 44 inches long. One of these is above, the other below a pivot point, which is a steel cross-shaft strongly secured to the frame by steel brackets. At the outer end of the springs the two axles are fastened by means of ball-and-socket joints, permitting a wide range of flexibility without distortion of the springs or frame. The driving force is transmitted through these springs, but torsion rods are provided to eliminate any twisting tendency in the first rear axle.

Since the foot brake operates through the transmission, it is applied to the same wheels as the driving force. The emergency brake operates on the four rear wheels, thus providing two independent sets of four-wheel brakes. The truck has the usual front wheel drive transmission with five forward and one reverse speeds, and with two sets of four-wheel brakes, it is invaluable for use over poor roads.

A High Speed Road Maintainer which can be hauled at a speed of 12 m. p. h. and leave a smooth surface, has been tested recently on New Mexico's gravel roads. An ordinary maintainer cannot run more than 4 m. p. h. to avoid vibration and chattering, although some machines have attained a speed of 6 m. p. h. by having the forward blades at a more acute angle, and weighing about 2500 pounds.

This new machine weighs 2,100 pounds, including extension blades. The width of the blades from out to out is 11½ feet, making it possible for a 23-foot roadway to be covered by a round trip. The special feature of this maintainer in overcoming vibration consists of three stabilizer blades, two in front — one on either side and one at the rear center — all being set vertically and parallel to the center line of the roadway. Pressure or elevation of these blades is controlled by the operator to prevent side sway and chattering.

Hauled by a two-ton truck it can attain a speed of 10 to 12 m. p. h. — in some cases, 15 m. p. h. — and with two units in tandem, 80 to 120 miles of road can be covered in a day. Subsequently, savings will be effected in lower purchase and operation costs on account of lower power needs.

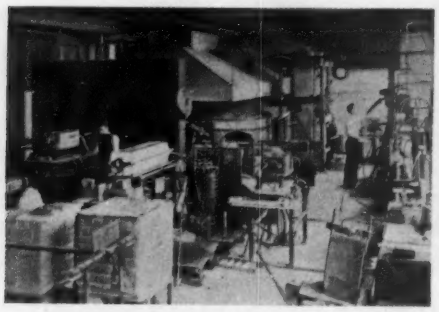
A New Wall Insulation of wood fiber board is being made by a mid-western company. It is made in units of 3 feet in length and of 16 to 24 inch widths, each unit consisting of a corrugated board folded in the center, with the two loose ends fastened together.

The board resembles a hollow I-beam in appearance, and three air spaces are provided between the studding — one in the center of the unit and one on each side of the flanges. These 3-foot units are set vertically in the walls and horizontal header plates are also placed to prevent vertical circulation of air. The material in this insulation is slow-burning, vermin-proof, odorless and resists moisture.

Departmental Notes

DEPARTMENT OF PHYSICS

THE custom established some years ago of inviting lecturers from other institutions at home and abroad to give courses here has been followed by the Department of Physics this year, and a course of lectures was given by Prof. Werner Heisenberg, Director of the Institute of Theoretical Physics at the University of Leipzig on "Recent Developments in Quantum Mechanics." Prof. L. S. Ornstein, Director of the Physical Laboratory at



HEAT LABORATORY

the University of Utrecht, also gave a short course of lectures on intensity problems in spectroscopy and research on liquid crystals. During the coming year it is expected that Prof. P. Scherrer of Zurich will deliver a series of lectures running through several weeks on some phases of modern physics. Prof. Scherrer's lectures are counted among the most successfully illustrated experimental lectures in Physics, and should prove of unusual interest to the general student body.

Professor Hardy is continuing his work on color, which has resulted in the development of a color analyzer, and is now preparing to set up what is practically a standardizing color laboratory, which will be unique and of great scientific and industrial value.

Dr. Stockbarger has continued his work on ultra-violet radiation, particularly in his search for more effective sources of short wave-length radiation, and in the study of various media for transmitting such radiation with a minimum absorption. Work is also progressing on the study of the critical potentials of mercury vapor mixed with rare gases which was started last spring. The Radiation Laboratory has been transferred to larger quarters in the basement of Building 4, and its equipment is being greatly amplified.

Professor Frost has been carrying on an extensive photoelastic study of the stresses in grinding wheels which are particularly subject to the development of high stress from the strains due to rotation. Some very interesting modifications of the mathematical theory of disks in rapid motion have resulted.

Dr. Vallarta is continuing his researches in mathematical Physics, particularly in the matter of the spinning electron, and the field equations of Einstein's theory.

Prof. John Norton has been busy throughout the past year as a member of the Committee of the American Welding Institute studying the structure of welded joints as determined by radiographic methods. The work has been divided among several of the larger educational institutions and research laboratories, the joints under investigation being prepared by the General Electric Company and other manufacturers, the chemical analysis being made in one institution, the photo-micrographic study in another, and the X-ray study of the finished welds is made here at the Institute. Dr. Warren has been working all summer in the X-ray laboratories at Manchester, England, with Prof. W. L. Bragg, and will be back at the Institute about November 1. His last paper on the structure of some silicates was printed jointly with Professor Bragg.

Mr. Phelan has spent the summer in the Mid-Continental oil fields working on geophysical problems.

Professor Wilkes has extensively overhauled the equipment of the Heat Measurements Laboratory, and a considerable portion of the gas equipment has been condensed and replaced. Some notable additions to the set-up of the regular laboratory experiments have also been made.

Dr. Barss has recently been working in coöperation with some of Boston's physicians in the preparation of a noise-producing machine with which the physiological effects of noises may be studied. It will, of course, be appreciated that the problem of noise in our large cities has become a most serious one.

Dr. Müller is carrying on the development of his study of dielectric phenomena with an unusually large group of students.

Professor Sears has added a number of new experiments to the set-up of the second year Heat Laboratory. He is also working on a theory of the Barkhausen-Kurz effect of making use of the integraph developed by Professor Bush of the Electrical Engineering Department.

Drs. Müller, Knobel, de Laszlo and Frank have been in Europe this summer visiting educational institutions, and Dr. Frank will continue throughout the year, studying principally at Munich.

Graduate work in Ceramics has been authorized as a portion of the Department's duties, and F. H. Norton has been appointed assistant professor of Ceramics. Two of the Physics laboratories have been converted into laboratories for experimental ceramics, and considerable equipment is being installed for this work.

The investigation which has been carried on for a number of years for the Babcock & Wilcox Company on the creep of steel at high temperatures has reached a stage where it has become possible to publish a portion of the results, and they have appeared in a book written by F. H. Norton, published recently by McGraw-Hill Book Company.

Professors Drisko and Page have made further revisions of the schedule and set-up of the sections in first and second-year Physics with a general result that both lecture and recitation sections are being reduced in size with some considerable increase in efficiency.

A very extensive overhauling of the general schedule for Course VIII has been made during the year, and has resulted in what is believed to be a decidedly strengthened curriculum. The work, which is distinctly graduate in character, has been a little more definitely outlined and placed in the graduate years, and the fourth year has been left with a great deal of time available for options, so that a student who is particularly interested in one

(*Continued on page 210*)

APPARATUS FOR THE MEASUREMENT OF THE CREEP OF STEEL

Both are lines of national defense

THE Mississippi was a menacing flood. The telephone was the first line of defense, for over its wires the work against the flood was directed. Maintenance crews performed the same service as did telephone men in the signal corps in the war.

In the daily life of the nation, just as surely as in emergency, the telephone meets an ever-growing stream of demands.

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"OUR PIONEERING WORK HAS JUST BEGUN"

Recent Books

This department conducted in co-operation with the faculty

An Introduction to Crystal Analysis. *By* SIR WILLIAM BRAGG, K.B.E., D.Sc., F.R.S. *D. Van Nostrand Co., Inc., New York City. 1929. 168 pages + vii. Price $4.25.*

In 1912, M. Lave suggested the trial of an experiment which, if it were successful, would prove that X-rays were of the same nature as light. It was tried, and succeeded. Although this experiment was important in the achievement of its original purpose, its unforeseen consequences have been even more striking, for from this experiment a method came for the examination of solid bodies. The importance of this unexpected result need not be stressed, for although much is known chemically concerning solid substances, the nature of their internal physical construction has been rather hazy. The experiment opened a new field of research to the physicist.

This book was originally a course of lectures given by the author. It is designed to explain to the person unfamiliar with the subject its underlying principles. Although the author assumes, on the part of the reader, a knowledge of physical terms, only an elementary knowledge of mathematical and physical principles is required of the reader for the complete comprehension of the book. It can be read with facility by anyone interested in science.

The book tells of the development of X-rays as a means of studying the structure of matter. A description is given of the methods of analysis, results are interpreted through the use of photographs and drawings; the atomic structure of solids is studied, and the final chapter deals with the investigation by X-ray of metals and alloys.

J. H. D., JR.

Television — Present Methods of PictureTransmission. *By* H. HORTON SHELDON, PH.D., *Chairman of the Department of Physics, Washington Square College, New York University; Science Editor, New York Herald Tribune; and Edgar N. Grisewood, M.A., Instructor of Physics, New York University. 194 pages, illustrated. D. Van Nostrand Co., Inc., New York. Price $2.75.*

The book is an attempt on the part of the authors to give in one small volume a short comprehensive review of the development of television. In this attempt they have succeeded to an admirable extent. Their book will still be a help to the amateur experimenter long after commercial laboratories have placed foolproof apparatus on the market.

Following a preface and an introduction which give a bird's eye view of past achievements and future possibilities, come two chapters — the first on the essential elements of television and the second on its historical background. After having read thoroughly these two chapters, the amateur will be in position to understand, provided he has an elementary knowledge of electricity, the more detailed and technical discussion which fills the remainder of the book. Lest, however, his knowledge of these subjects be somewhat hazy, a clear, concise review is given of such of the principles of optics and of electromagnetism as are used in the most recent experimental sets. Though this section may be scorned by the recent graduate of a technical college, it will undoubtedly be a great help in refreshing the memory of a less fortunate reader.

The remaining hundred and fifty pages are devoted to a discussion of the numerous problems which have been met, of the various solutions which have been found, and of the multiplicity of modifications and refinements of the first successful machines. Numerous diagrams and photographs help to explain such apparatus as could be described only in highly technical language, and many references are made to existing texts which go more thoroughly into details of past experiments. These references should be particularly useful to the man who means to make a thorough study of the subject.

Last but one is a chapter on the problems to be met by the amateur, and in conclusion, the authors make prophecies which show remarkable restraint, in view of the mushroom-like growth and remarkable achievement in the past few years.

R. C. M. C.

Introduction to Theoretical Physics. By LEIGH PAGE. *1 vol. of X and 587 pp. New York, D. Van Nostrand Co., Inc., 1928. Price $6.50.*

This book, by the Professor of Theoretical Physics at Yale University, is intended as a text for first-year graduate students and for seniors specializing in physics. In the words of the author, its aim is "to provide the student in an elementary way with a survey of the whole field of theoretical physics." This, of itself a sufficiently ambitious program, becomes a staggering task at a time when theoretical physics is in such a state of flux that the most cherished acquisitions of yesterday — the A B C of Newton, Laplace and Maxwell — are questioned today or altogether discarded. In physics, as in other branches of science, there is no royal road to knowledge; it must be coaxed and won at the risk of error. Stagnation and self-satisfaction are the only unforgivable sins of the natural philosopher. Physics in its essence is knowledge of Nature, and this knowledge cannot be furthered without the close collaboration of theory, which plans and interprets, and experiment, which executes and tests. The study of theoretical physics, much neglected in this country for generations past, is just coming into its own. The call for texts to suit the needs of American students has consequently grown to the point where it can no longer be ignored. Students of physics are indebted to Professor Page for a well-knit, concise, understandable text which, while neither over-critical nor bent on too literal a fulfilment of its promises, neither ultra-conservative nor decidedly modern, constitutes a sound introduction to the methods of theoretical physics.

The book begins, in accordance with time-honored canons, with an introduction to vector analysis extending from the elements of vector algebra through the theorems of Gauss and Stokes into dyadics. The use of the word "tensor" as a synonym of dyadic, although authorized by old usage, is in the reviewer's opinion an unfortunate choice. The usual elementary proofs of Gauss' and Stokes' theorems are rendered, but why not point out their limitations even in an elementary text? Heaviside once remarked that to the physically minded Gauss' theorem needs no proof. Many will disagree, but if a formal proof must be given, why not speak of its weaker points? Although in no sense an ardent quaternionist, the reviewer believes that to point out the relation between vectors and quaternions is very much worth while. Felix Klein, in his inimitable style, has already shown that quaternion multiplication is something very useful, even though one may be repelled by the intricacies of quaternionic calculus.

The next four chapters are devoted to mechanics. A notable omission is a discussion of the fundamental concepts of mass and time, although inertial

(Continued on page 204)

MAKING BORE HOLES

Lesson No. 4 of Blasters' Handbook

A BORE HOLE may be anything from a shallow hand-drill hole in a boulder to a deep, well-drill hole or a tunnel 100 or more feet long. And in all the great variety of bore holes between those extremes lies a startling complexity of methods, conditions, precautions and implements.

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Prevention of Mine Accidents

(*Continued from page 177*)

by mine fires and explosions have been saved through their knowledge of the proper construction of barricades behind which they can be protected against the poisonous fumes. A large percentage of those killed by mine fires and explosions are victims of the deadly gas, carbon monoxide, and a general knowledge of the proper construction of barricades would undoubtedly result in saving a greater number of lives at these disasters. Barricades may be built from lumps of coal, slate, rock, ore, or boards, stopping the cracks or holes with clay, clothing, or similar material. When a fire or an explosion occurs in a mine, the natural impulse of the survivors is to dash to the nearest exit. But if the smoke and gases are too strong and are advancing on the men they should retreat rapidly to a place favorable for barricading. While retreating, the miners should collect tools, canvas, boards, water, and dinner buckets, as well as any other material which they think likely to aid in erecting a barricade. According to the records of the bureau, barricades in mines have saved at least 555 lives. This number would undoubtedly be much larger if other miners had made an effort to erect barricades instead of rushing into poisonous atmospheres in an attempt to reach the surface. Some few mines have provided underground refuge chambers into which miners might retreat following fires and explosions, and close themselves in until help arrives. Such chambers are usually provided with drinking water, food, and either compressed air or means of ventilation through holes drilled from the surface.

Approximately 2,300 lives are lost annually in the coal mines of the United States. Due to the wide publicity given by the press to mine explosions or fires where scores of men are killed, the opinion of the general public is that such explosions and fires are the cause of most mine fatalities, while, as a matter of fact, explosions and fires account for only about 15 per cent of the fatalities occurring in mines. Falls of roof and coal are responsible for the greatest loss of life in mining, about 50 per cent of all fatalities being from this cause. About 15 per cent of these fatalities are caused by haulage accidents and about 5 per cent by electricity, through direct contact.

The tragic coal-mine fires and explosions that frequently shock the nation are generally caused by the ignition of explosive gas, mainly by means of open-flame lamps, explosives, and arcs from electrical equipment. The initial blast raises into suspension and fires the accumulation of highly explosive coal dust, which then propagates the explosion throughout the mine. A system of rock-dusting bituminous coal mines is now being more or less adopted as a means of limiting and preventing propagation of explosions. By rock-dusting is meant the covering of the walls, roof, and floor in every part of the mine with a coating of quantities of finely pulverized rock dust. When a minor or local explosion occurs, the advance air wave, always set in motion by it, precedes by a fraction of a second the onrush of the flame, and projects the rock dust into a cloud or screen which usually cools the flame and aids in checking the exploding of the coal dust, holding within a very small area what otherwise would in all probability develop into a mine-wide disaster; the rock-dusting is effective only when done thoroughly and kept in such condition that dust thrown into

(*Continued on page 194*)

Purdue
Vassar
Johns Hopkins
Catholic University
Wisconsin
Ohio State
Kansas
Princeton
Michigan
Duke
Detroit
Concordia
Tennessee
New Hampshire
Penn State
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Choice of America's Colleges

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Pavers, Mixers—Gasoline Shovels, Pull Shovels, Cranes and Draglines

KOEHRING HEAVY DUTY NEC

Division of
National Equipment Corporation

Mine Accidents

(*Continued from page 192*)

the air by the explosive wave has a combustible content of much less than 50 per cent of the whole.

The Bureau of Mines has been exerting much effort to supply those who are engaged in the mining industry with available information regarding mine hazards and safe mining practices. Investigations and experiments conducted by the bureau have proved that the contributory causes resulting in loss of life in mining can be eliminated to a great extent by the application of suggestions found in publications issued by the bureau. Mine-rescue work is usually necessary because of the recklessness or carelessness of some individual or because of the failure of the operating company to apply the lessons learned as to how to prevent or limit these explosions. Disasters from such causes are being reduced in number and severity, however, and it is hoped that this result is at least in part due to the safety educational work of the U. S. Bureau of Mines.

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STANDARD
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The Gyroscope

(*Continued from page 182*)

holding its plane of swing at the latitude of Paris as the earth rotated about its axis.

Not content with this demonstration, however, a few years later Foucault again demonstrated the rotation of the earth, with even more refinement and by an entirely novel means. He constructed for the purpose a gyroscope so sensitively supported that when it was spinning it held its fixity of plane in space well enough to demonstrate the earth's rotation about it. It was Foucault who gave the name gyroscope to this device, and it is evident how the name reflects the purpose for which he built this instrument, as it comes from the two Greek words "gyros" which means rotation, and "skopein" which means to view; in other words, an instrument for viewing the rotation of the earth.

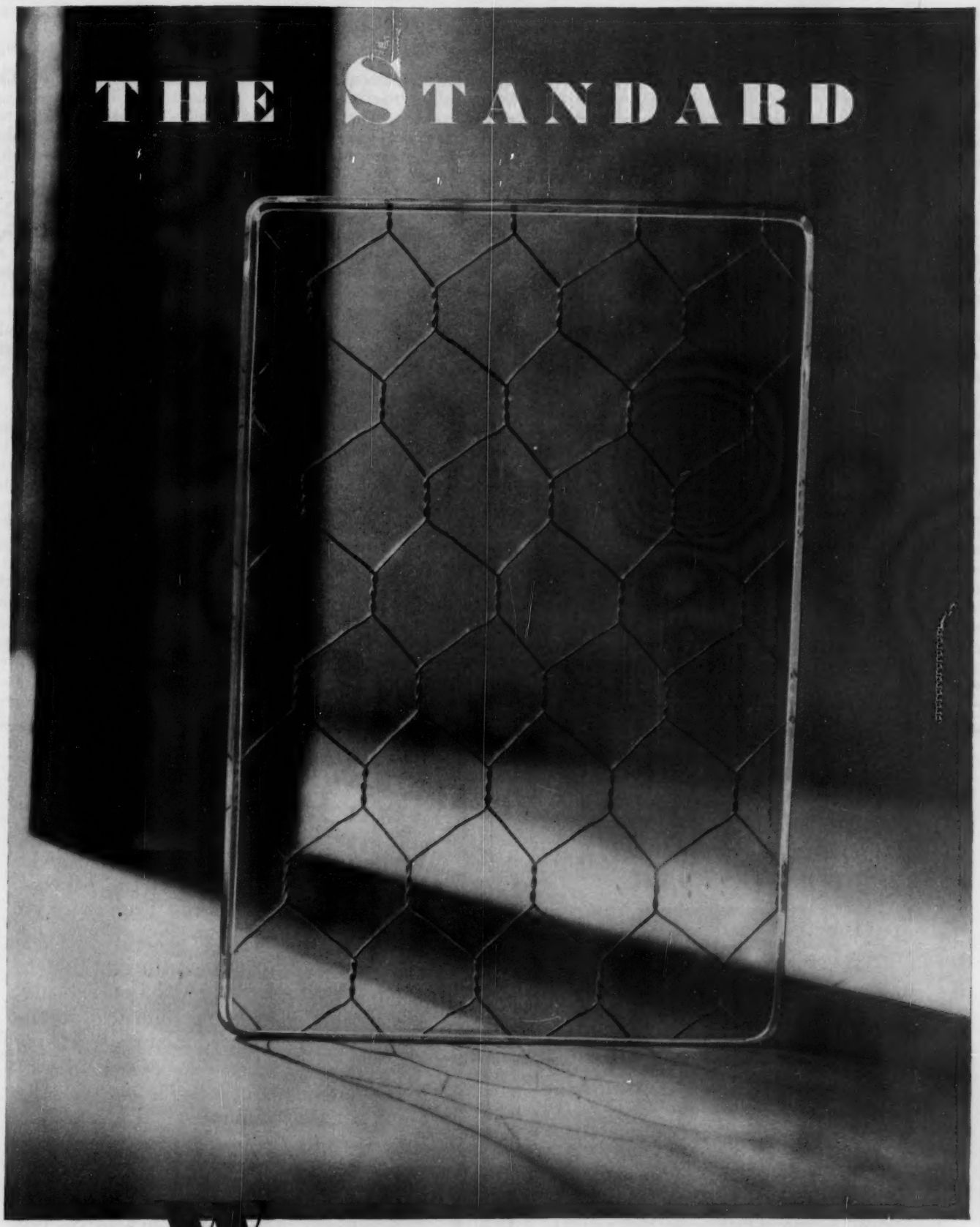
It is a great credit to the skill of Foucault that he was able to make a gyroscope so well balanced and accurate that it maintained its axis fixed in space accurately enough to demonstrate that the earth rotated while the gyro axis did not. But even after this demonstration of the possibilities of the gyroscope, no practical applications were made for years. During these years, however, enough interest was manifested in the possibilities of gyroscopes so that we find occasional published dreams and even quaint patent applications for various uses of the gyroscope. But the electrical art had not yet progressed to the point where it was possible to make a gyroscope which would maintain its speed and this, of course, is an essential of a practical application. Not enough was understood about gyros to make these early patents of much more value than the mere rudimentary ideas that such practical uses might be possible. One of the most interesting of these was a patent by a Dutch Minister Van den Bos, granted as long ago as 1885 for a gyroscope compass. The idea was there, but unfortunately the compass would have worked only on land, as the rolling of a ship would have made it useless.

It was in the field of steering torpedoes that the gyroscope first found practical application. The torpedo is a device for exploding a charge against a ship. The crude beginning of this effective weapon was called the outrigger torpedo which was, strange to say, actually successful to some extent during the Civil War. It consisted of carrying the charge to be exploded on the end of a long pole from a small boat and, under cover of darkness, running the boat up to the enemy's ship and exploding the charge against it. It frequently, also, blew up the small craft and the brave torpedoman had to rescue himself as best he could. The effectiveness of torpedoes, however, was so great that nations endeavored to find better means for sending them against the enemy than that of sending a man along with them. Various devices were tried for propelling the torpedoes, such as pulling wire from spools which were geared to the torpedo propeller. One of these schemes was to utilize the inertia stored in a heavy flywheel by spinning up the flywheel to a high speed before the torpedo was released, and allowing this energy to propel the torpedo. An unlooked-for advantage was found in this flywheel torpedo, in that it had a tendency to go in a straighter line than any of the other schemes and it was immediately evident that it was the gyroscopic effect of the flywheel which kept the torpedo more nearly on its course.

Then came the development of compressed air engines which were more efficient than any of the previous schemes. In 1896 Lieutenant Obry, a young Austrian naval officer, developed a gyro control for the Whitehead compressed air torpedo and this was the beginning of the modern torpedo. In this country the development was made by Mr. Leavitt, who perfected the Bliss-Leavitt torpedo which had greatly increased efficiency in range over the previous types of torpedoes. He increased the radius of action by a bold piece of engineering in automatically burning a fuel directly in the pressure air current, thus greatly increasing temperature and efficiency. He replaced the reciprocating Whitehead engine with small turbines and the control gyro with the sensitive valves through which it operated the rudder was refined to a point which gave the torpedo remarkable accuracy.

The next field, and probably now the most useful and widespread application of the gyroscope, is the gyro-compass. The magnetic compass, which had carried the sailing vessels and wooden ships through the era of exploration and trade expansion, was fast getting into difficulty on account of the coming of steel ships. The steel caused serious errors in the magnetic needle and made it necessary to carefully compensate the magnetic compass for these errors by various magnets and iron spheres. The skilled profession of compass adjuster was created. But at best these compensators weakened the directive force of the earth's magnetic field and always called for readjustment to prevent errors and uncertainties from creeping in.

(*Continued on page 196*)



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The Gyroscope

(*Continued from page 194*)

After 1900 considerable study and experimenting were made with a new principle of indicating the north which utilized the gyroscope. Mr. Sperry, after a great deal of experimenting, produced his first gyro-compass in 1910. The Navy became much interested in the success of this machine because the modern battleship had become a "no-man's-land" for the magnetic compass. The huge masses of steel comprising the turrets and guns exerted a greater influence on the compass needle than the feeble magnetic force of the earth. Exhaustive tests of the gyro-compass were so encouraging that further development was made and the Navy adopted this non-magnetic compass for its large battleships and submarines. The news spread fast of the development of this new type of compass which was dependent in no way on the earth's magnetic field and which pointed to the true north rather than the magnetic north. Soon all of the large navies of the world were equipping themselves with this new instrument, even before the beginning of the World War. During the war all of the participating navies navigated by gyro-compass so that by the time of the armistice the gyro-compass was a well-established navigation instrument. Up to 1919, however, all gyro-compasses were confined to naval use. They were highly developed, expensive pieces of equipment. To meet the demands of the merchant marine, it was necessary to simplify and make less expensive this piece of apparatus, without sacrificing performance. A difficult task, but now, ten years later, an idea of the success of applying the gyro to the merchant marine may be gathered from the fact that there are now over one hundred steamship companies who are navigating their ships by Sperry gyro-compass.

During these years of service in the merchant marine, the gyro-compass has added greatly to the services which it is performing for the navigator. The fact that the compass is non-magnetic and points true north is now only one of numerous advantages of the gyro over the magnetic compass. The main advantage of the gyro is its capability to serve as a master from which other very important accessories are operated. The gyro-compass always has had repeater compasses; that is, the master compass transmits its indication to various electrical repeater dials. This allows the master to be placed in a suitable location and only the repeater compasses need to be placed on the bridge. The next addition to the gyro-compass family was the course recorder, which is a repeater that graphically charts the course of the ship, showing each minute deviation. The recording paper is moved by clockwork under the pen and the pen is shifted by the master gyro-compass. This instrument has been found to pay its way as insurance in times of emergency, where it faithfully records the facts at the time of a collision or other catastrophe. The truth of its record has already stood in court against the less accurate stories of other witnesses who have no verification of their actions.

The last and most important addition to the family is the gyro-pilot, better known as "Metal Mike." This instrument takes over the duties of the quartermaster or helmsman and holds the ship on whatever course it is set. Few people are aware of the fact that for several years now the *Leviathan* has been crossing and recrossing the Atlantic without having any man at the wheel, and it is only one of several hundred ships that are now navigating accurate courses without a human helmsman.

(*Continued on page 198*)

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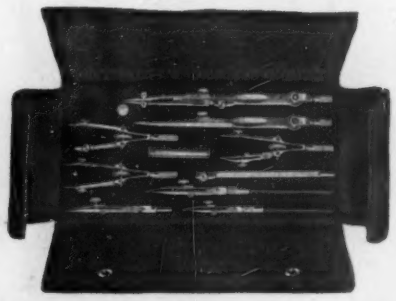

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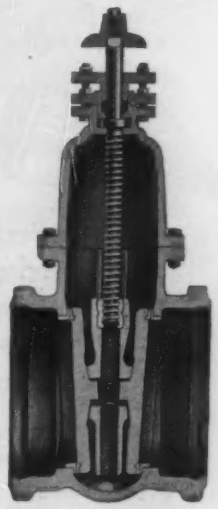

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The Gyroscope

(*Continued from page 196*)

But the application of the gyroscope which excites the most interest is the gyroscopic ship stabilizer. That is the only application of the gyroscope, so far, that makes use of the tremendous precession forces which may be obtained in large, rapidly rotating gyros. The history of rolling ships and attempts to stabilize them is very interesting. The old sailing vessels were all very well stabilized. The stabilizer was the wind-filled sails which held the ship steady in the rolling sea very effectively. Here again the coming of steam vessels with the elimination of the sails and the tendency toward long, fine lines introduced excessive rolling as a serious problem for the first time. Many marine engineers turned themselves to the problem of decreasing the excessive rolling of these steamships. Dr. Frahm of Germany developed a system of anti-roll tanks which were tanks partly filled with water connected by pipes or siphons which would allow the water to flow from one side of the ship to the other and were so arranged that this water had a tendency to stay out of phase with the waves or rolling of the ship and thus tended to reduce the roll of the ship by this shift of weight. These tanks, however, were very heavy, cumbersome and noisy, and at best they merely reduced the roll to some extent, but could not eliminate it.

Sir John I. Thornycroft of England attacked the problem from the point of view of having a large pivoted weight which worked in principle similar to the Frahm tanks; that is, it was swung from side to side by hydraulic apparatus in such a period that it tended to counteract the roll of the ship. This instrument also was heavy and needed considerable room for its installation, and, of course, the effectiveness of it depended entirely on how much weight could be afforded in the shifting element. But none of the water-tank or weight-shifting devices came into general use and the bilge keel was the only roll-reducing device which was generally utilized. The bilge keel, which consists of fins extending from the lower sides of the hull, by no means eliminates roll but reduces it to some extent by acting as vanes or dampers in the water about the rolling axis of the ship.

The first attempt to stabilize a ship by means of a gyroscope was made by Dr. Schlick of Germany. He designed and installed on board the *Silvanna* a large gyroscope which was caused to precess whenever the ship started to roll. This is the simplest arrangement of a stabilizing gyroscope and is called the passive type because it starts to act only after the ship has started to roll. Its use has not been continued. At this point Mr. Sperry took up the problem and developed his ingenious active type of gyroscopic stabilizer. This type has proved very successful and its performance never ceases to be a matter of astonishment to mariners and landlubbers alike who see its action for the first time.

The Sperry stabilizer is called the active type because, instead of allowing the rolling of the ship to precess the stabilizing gyro, a small or secondary sensitive gyro closes an electric circuit which causes the stabilizing gyro to be forcibly precessed by an electric motor. This motor precesses the gyro in such a direction and at such a rate that the gyro transmits to the ship's hull a force exactly equal and opposite to the force which the wave is exerting on the ship in attempting to roll it. Since the force of this wave is just neutralized, the ship stays on a steady keel, and as the wave passes under the ship the gyro is forcibly precessed in the opposite direction to keep the ship from rolling in the

(*Continued on page 200*)

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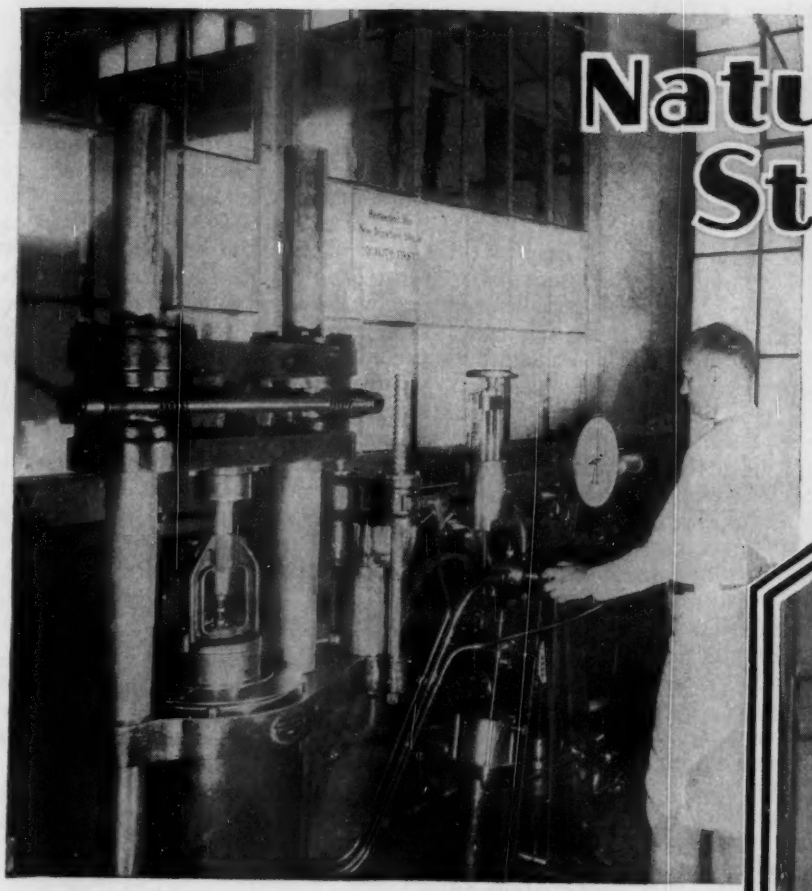

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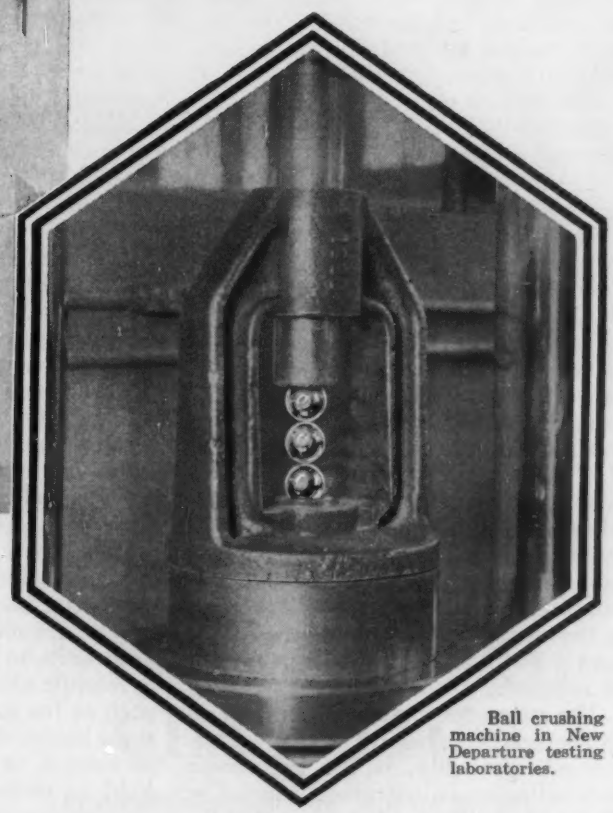

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NEW DEPARTURE

BALL BEARINGS

1277

The Gyroscope

(*Continued from page 198*)

other direction, so that when the next wave comes it again finds a ship on an even keel, and again tries to start the ship to roll. It is here that the secret of the success of the active gyroscope is evident. An unstabilized ship is a pendulum. No single wave makes it roll to any extent, but the continued impulses of wave after wave build up the roll of the ship. Now with the stabilizer if the ship is stabilized sufficiently to counteract the force of the first wave, then, of course, there is no second wave, but each succeeding wave is the first wave, so the ship never starts to roll. It is found from experience that a ship which is unstabilized might roll as much as forty degrees and can be held quite level by a gyroscope which only has the power of stabilizing for a five degree roll, which we will say is the increment that one wave may add to the ship's roll. Therefore we can see that the gyroscope can be made relatively much smaller in size with respect to the ship than one would normally expect and in practice it has been found that a rapidly rotating mass of 1 per cent of the ship's weight is sufficient to completely stabilize the other 99 per cent. There are now about twenty of these ship stabilizers in active and successful operation. Their use will probably become more widespread as the device has more experience behind it and when its initial expense can be reduced.

The gyroscope has also found several applications in aviation. The most important, probably, is the gyroscopic turn indicator, an instrument carried by all Air Mail pilots and also by all of the renowned trans-oceanic flight planes. This instrument consists of a small gyroscope spun by air which is so mounted that it is caused to precess rapidly if the airplane turns slightly from a straight course. A pilot by watching the instrument is therefore able to fly a straight course even though he cannot see any objects ahead or on the ground. This instrument is indispensable at night and in fog or clouds. It is the instrument which makes blind flying possible. Lindbergh claims to have flown hours by it without getting a glimpse of the ground.

Another use of the gyroscope in airplanes is for stabilizing the plane. Mr. Sperry produced the first gyroscopic airplane stabilizer in 1914 and was awarded the grand prize in France for its performance in that year, Airplane stabilizers have been in more or less use since then but, on account of the great improvement in the inherent stability of airplanes, the gyroscopic stabilizer has not been as essential as it was once thought that it would be. Now, however, with the scheduled flights of large planes over definite courses or airways and for tedious hours for the pilots, the gyro-stabilizer is undoubtedly coming into its own again, not as a safety measure to keep the plane steady and upright but as a device for relieving the continued strain on the pilot during long flights.

In looking back over the various applications in which the gyroscope has found a field of usefulness, it will be noticed that they all apply either to marine or aviation work. This is to be expected, since the properties of the gyroscope lend themselves especially to uses where something fixed or rigid is needed in an unsteady medium. The gyroscope either is used to indicate data such as the meridian or the vertical of some known direction for either marine or aviator, or else it is used to forcibly hold an unstable object, such as ship or airplane, in approximately a level position.

Now, however, Mr. Sperry has found a most ingenious use for the gyroscope which finally brings it onto the land. This latest application of the gyroscope is in connection with railroading, and is called the automatic track recorder. A gyroscope has been developed for mounting on a special railroad car for recording the evenness of the roadbed. Through a system of levers and pens which mark graphically red lines on a slowly moving sheet of paper, the gyroscope pen continually records the true vertical and a pen mounted to the car trucks records the angle or tilt of the rails. The first of these track recorder cars has now travelled over sixty thousand miles at rates from twenty miles per hour to seventy miles per hour and has faithfully recorded the levelness of track over every mile that it has been pulled. It, of course, saves a great deal of track inspection and surveying since these records are turned over directly to the section foreman who can seek out and repair the uneven spots from the charted record.

A Diesel Airplane Engine, in a test this spring, gave new stimulus to the problem of adopting the Diesel principle to the airplane when it consumed only $4.68 worth of fuel in traveling 650 miles, whereas in an ordinary engine twenty-five dollars worth of fuel would have been consumed.

The advantages of an engine of this type as outlined by prominent engineers include low cost of fuel; elimination of fire hazard due either to electric ignition or to back-fires through the carburetor, since both ignition and carburetor are eliminated; decreased fuel consumption; elimination of interference with radio communication, due to the absence of electric ignition; and the possibility — not yet demonstrated in flight — of using a two-stroke cycle with consequent low engine revolutions at moderate speeds, and a resultant increased efficiency of the propeller.

On the other hand, the disadvantages, which to some engineers seem of the utmost importance, are greater specific weight — due to the heavier cylinders necessary to accommodate the high internal pressure generated; higher first cost; difficulties of maintenance due to the fuel injection system used; the non-uniformity of furnace oil; lack of cleanliness; and the limited distribution of supply sources

---

Airways of this country now extend over 21,392 miles. Transport companies which operate over these airways are flying about 57,516 miles a day. The nine foreign airways operated by American interests total 4,442 miles of the airways. Air mail services account for 39,216 miles of daily flying, and passenger services for 18,300.

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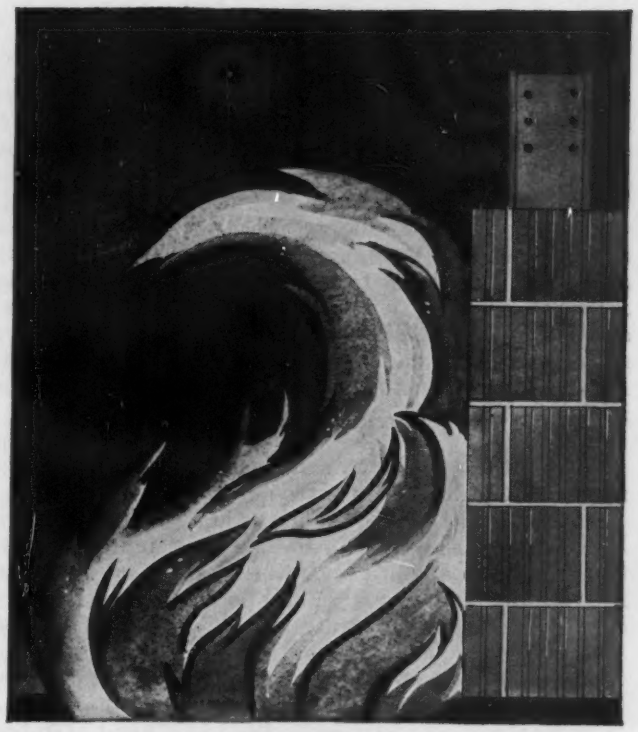

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1453 ENGINEERING BUILDING CHICAGO, ILLINOIS

The New York Port Authority

(*Continued from page 179*)

and that it furthermore placed these structures at the service of the public nine months in advance of schedule.

The Kill van Kull Bridge will have a total length from plaza to plaza of 6,380 feet. The plans adopted were for an arch type as combining economy and ample rigidity in traffic, with the appearance necessary for a span in the selected location. It is to have a single deck. It will be made strong enough, however, to carry, in addition to the initial four-lane roadway, two rapid transit tracks.

The Arthur Kill vehicular bridge routes constitute alternatives for the densely traveled route via Jersey City, Newark and Elizabeth, New Jersey, to and from the south and southwest from Manhattan, Brooklyn and points east. They also constitute the only highway vehicular crossings between the mainland of New Jersey and Staten Island, which was formerly served only by three steamboat ferry crossings, two of which are in the immediate vicinity of the bridge crossings.

On the principle that population follows transportation, Port Authority spokesmen frequently have declared that its plans for these bridges and its other projects will bring about a more equitable distribution of population in the New York–New Jersey region. Among its other activities, the Port Authority is coöperating with the North Jersey Rapid Transit Commission in studying plans to relieve congestion in the entire district.

The Port Authority has been of service to a number of municipalities in investigating the possibilities of marine terminals and has also given similar aid to the improvement of channels and waterways in various sections. One of several surveys made by the Port Authority was at the request of the poultry trade of the metropolitan district and advised establishment of a union live poultry terminal for New York–New Jersey at Weehawken.

What the commissioners of the Port Authority believe is justified and impersonal pride is taken in the financial chapter of the Port Authority history. To have attained a recognized investment standing in financial circles is a notable achievement in itself, after the comparatively brief existence of this organization. Financial standing is essential to success, for the Port Authority cannot under the law attempt anything not economically practicable. A $12,000,000 bond issue for the Kill van Kull Bridge was sold shortly after the close of 1927, at a cost to the Port Authority of 4.0109. Previous bond issues have been given a high standing.

The Port Authority, in seeking to coördinate and extend the facilities of the Port of New York, proceeds in pursuance of these fundamental principles:

First, that terminal operations within the Port District, so far as practicable, should be unified.

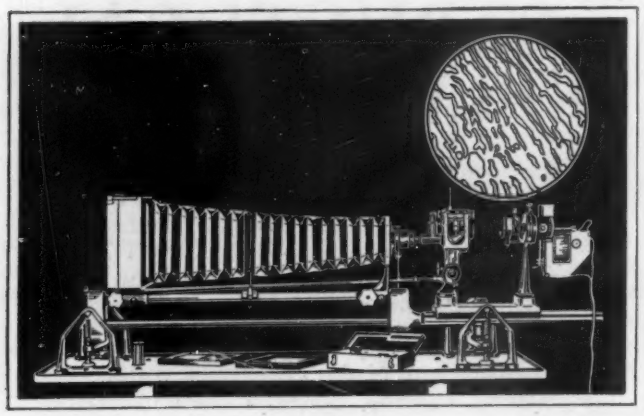
Second, that there should be consolidation of shipments at proper classification points so as to eliminate duplication of effort, inefficient loading of equipment and realize reduction in expenses.

Third, that there should be the most direct routing of all commodities so as to avoid centers of congestion, conflicting of currents and long truck-hauls.

Fourth, that terminal stations established under the comprehensive plan should be union stations, so far as practicable.

Fifth, that the process of coördinating facilities should so far as practicable adapt existing facilities as integral parts of the new system, so as to avoid needless destruction of existing capital

(*Continued on page 204*)



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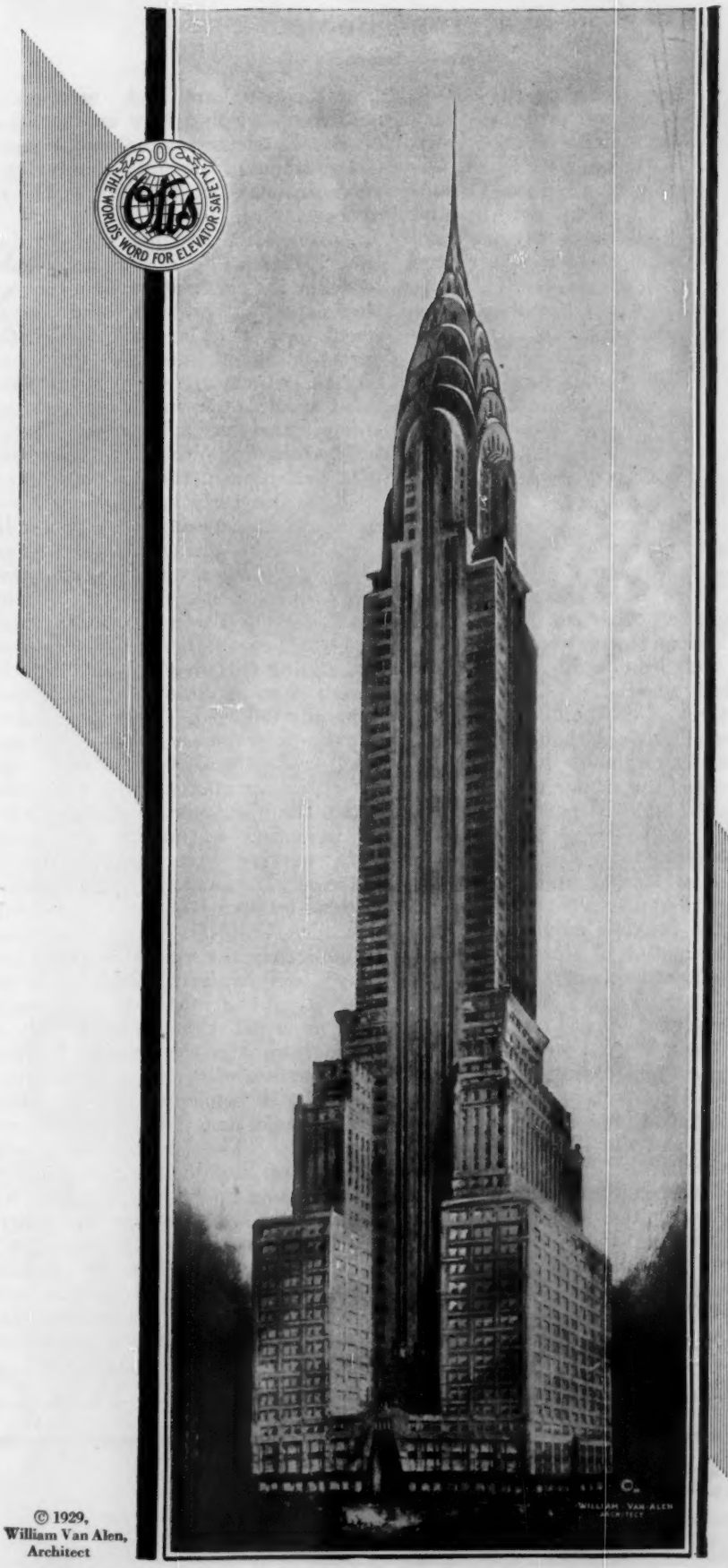
H. C. S.
76 MASSACHUSETTS AVENUE



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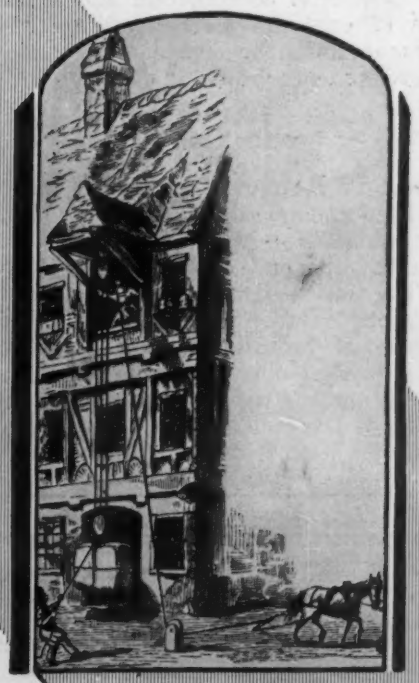

OTIS ELEVATOR COMPANY

OFFICES IN ALL PRINCIPAL CITIES OF THE WORLD

New York Port Authority

(*Continued from page 202*)

investment and reduce as far as may be possible the requirements for new capital; and endeavor should be made to obtain the consent of the states and local municipalities within the Port District for the coördination of their present and contemplated port and terminal facilities with the whole plan.

Sixth, that freight from all railroads must be brought to all parts of the port wherever practicable without cars breaking bulk, and this necessitates tunnel connection between New Jersey and Long Island, and tunnel or bridge connections between other parts of the port.

Seventh, that there should be urged upon the Federal authorities the improvement of channels so as to give access for that type of water-borne commerce adapted to the various forms of development which the respective shore fronts and adjacent lands of the port would best lend themselves to.

Eighth, highways for motor truck traffic should be laid out so as to permit the most efficient interrelation between terminals, piers and industrial establishments not equipped with railroad sidings and for the distribution of building materials and many other commodities which must be handled by trucks, these highways to connect with existing or projected bridges, tunnels and ferries.

Ninth, definite methods for prompt relief must be devised that can be applied for the better coördination and operation of existing facilities while large and more comprehensive plans for future developments are being carried out.

A New Ball Retriever for golfers has just been announced.

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Recent Books

(*Continued from page 190*)

systems are introduced at the outset. A number of specific problems, such as the inevitable oscillator, are treated by the methods of Newtonian mechanics. The paragraph on Coriolis acceleration at the end of the first chapter and that on the symmetrical top at the end of the second are good examples of a well-balanced, clear elucidation of vexing topics. Elasticity and elastic waves are summarily dismissed in Chapter III, and the next chapter is a brief but rather complete account of the fundamental methods of analytical dynamics. Oddly enough, although the chapter begins with the brachistochrone, no attempt is made to correlate this example with the more general methods considered in the same chapter and the reader is left to wonder why it is so obvious that the time of descent along a cycloid is less than that along any other path. The paragraphs on transformation theory and on the Hamilton-Jacobi equation are particularly good.

Chapter V is on the hydrodynamics of perfect fluids. Although the topic of waves is originally introduced in Chapter III, the reader must proceed for about a hundred pages before the "velocity of wave propagation" is more closely defined. The hydrodynamics of viscous fluids forms the subject of Chapter VI. The application of the Stokes-Cunningham formula to the motion of an oil drop in air (Millikan's experiment) is worthy of notice.

Thermodynamics and statistical mechanics begin in Chapter VII with the definitions of temperature and entropy, the Gibbs-Helmholtz equation, Joule-Thomson effect, the equation of Van der Waals and the Phase Rule. The following chapter introduces the notions of thermodynamic probability, entropy and the theorem on the equipartition of energy — the use of the word "principle" in this connection is another instance of an unfortunate terminology — and closes with the quantum partition of energy. The newer statistics of Fermi-Dirac and Bose-Einstein are not mentioned, neither do we find here any mention of the classical canonic and ergodic distributions. The next chapter is a good summary of the kinetic theory of gases.

It is a trifle disappointing to find that Professor Page does not choose to define the electrostatic field through the exploring particle, and consequently is not led to discuss the perturbation introduced in the quantity to be measured by the measurement itself, a physical fact which in the last analysis leads to Heisenberg's indetermination principle. The common definition of the magnetic intensity as the force on unit pole — a non-physical experiment which fundamentally cannot be carried out because of the non-existence of separate North and South Poles — is also a trifle troublesome. The reviewer has always regretted that Abraham's procedure in defining the magnetic intensity by means of an exploring coil is not more generally followed. The paragraph on the electron theory of metallic conduction is rather notable by an absence of critical remarks. On the other hand, the discussion of Faraday's law of induction as applied to circuits with moving branches (p. 386) is extremely praiseworthy, and should be read by many who are imbued with the idea that the Blv-law is more reliable than the general Faraday law. The quasi-stationary field forms the subject of the next few paragraphs, but as usual the reader is left to wonder what is the relation between the equation of decay of current in a circuit with condenser and resistance, for example, and the general Maxwell equations. The chapter closes with a none too illuminating paragraph on waves along wires. In Chapter XII Professor Page takes up the general Maxwell equations. On page 434 it is shown that no circuital equations are possible without the displacement current. Why this fundamental fact is not brought out much sooner and

(*Continued on page 206*)

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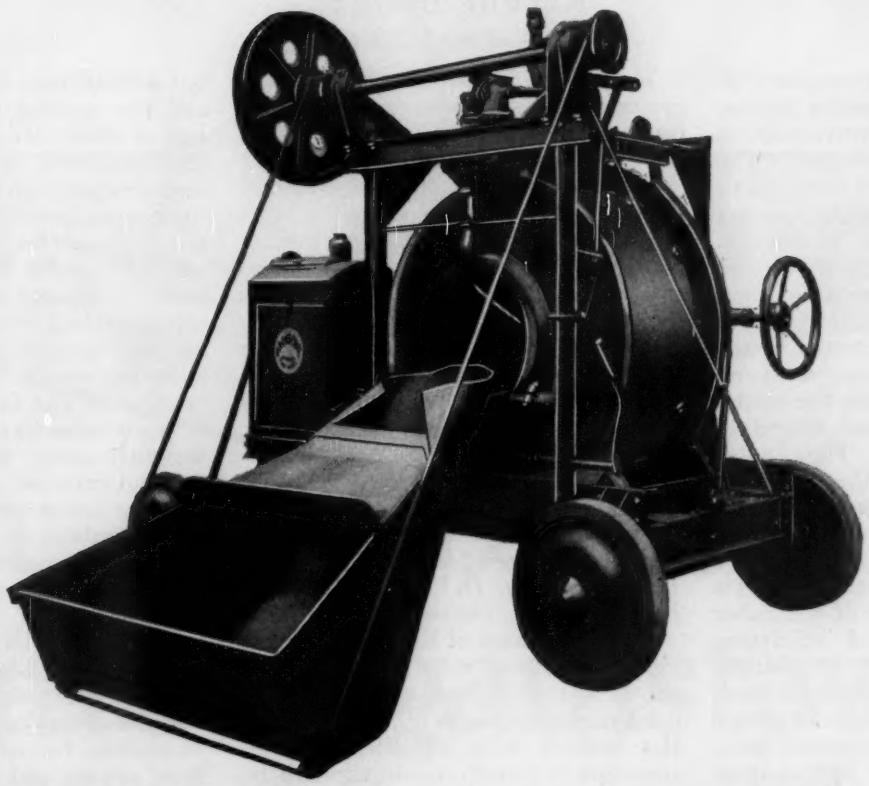

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Recent Books

(*Continued from page 204*)

why the displacement current, the culminating stroke of Maxwell's genius, is mentioned only surreptitiously, is something hard to understand. The balance of this chapter is devoted to waves in free space and the Lorentz transformation and their consequences. On page 465, in speaking of the Compton effect the photon is mentioned for the first time, but a few pages later the classical model of the light source is taken up, with its continuous wave, and again the reader is left to wonder why and wherefore the photon ever came up. The chapter closes with the Lorentz theory of the Zeeman effect and the radiation laws of Rayleigh-Jeans, Planck, Stefan-Boltzmann and Wien.

The chapter on geometrical optics is devoted to the treatment of a number of standard examples of refraction in lenses and prisms. Surprisingly enough, Fermat's principle is not mentioned. The same procedure of giving examples, but not fundamental principles, is followed in the next chapter on wave optics — why call them "physical" optics? The final chapter on the origin of spectra is a good summary of Bohr's theory.

The book is noteworthy by the systematic use of vector methods, and by the conciseness and accuracy of its style. On the whole it preserves a wholesome balance between completeness and detail. It does not always emphasize underlying fundamental principles and many times gives no inkling as to whether the results derived are or are not true. When supplemented by adequate classroom discussion it will undoubtedly be found very useful in an introductory course on theoretical physics.

M. S. VALLARTA.

English and Science. *By* PHILIP B. MCDONALD, *Associate Professor of English, College of Engineering, New York University. D. Van Nostrand Co., Inc. New York. 186 pages. Price $2.00.*

The importance of English to the engineer can hardly be overestimated, yet in a majority of cases it is the most neglected phase of his education. His contact with his clients or his superiors is usually made through reports and by these he is judged. Unless he can write clear, concise, forceful English, he is badly handicapped.

In the average engineering college but a small time is allotted to English and the student passes it off with a sigh of relief. He promptly forgets the little he knew, for his interest has not been aroused, and he makes no attempt to improve himself in his native tongue. Recognizing this, Professor McDonald has written his book in a way that radically departs from the accepted and usual method. Gone is the academic hair-splitting, the long lists of rules, parts of speech, and similar remembrances of the familiar English text. It reads more like an interesting and sprightly essay, teaching by comparison and example. Good, bad and permissible constructions are given in large numbers, so that the student unconsciously absorbs the difference between correct and badly constructed English. Many of his examples are taken from the most famous men of the past and present, which adds greatly to the interest of the book.

He devotes the first half of the book to reports, formal and informal, technical papers and letters. He includes numerous examples, two of the most interesting being by Colonel Lindbergh and Herbert Hoover. Both were

(*Continued on page 208*)

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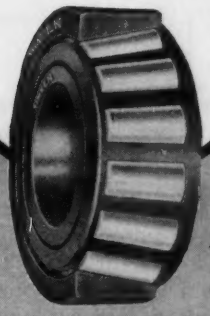

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Recent Books

(*Continued from page 206*)

written before they attained national prominence.

The next portion is devoted to the writing of good English. The author wars particularly on obscurity, pomposity and orateness. Many of his examples are quite humorous, which greatly increases the readability of the book. Verbose and wordy expressions of ideas are condensed to single sentences to illustrate conciseness, which, he claims, is the essential point for the engineer to master.

The last three chapters point out the necessity of wide cultural and general scientific reading for the professional man. He includes several suggested courses of reading and outlines the fields to be covered in such an interesting way that one's desire to go further in this line is immediately aroused.

This book would be a refreshing change for many short courses in Engineering English. To any undergraduate or young engineer who feels he is lacking in the essentials of English, it offers an excellent method of improvement.

C. F. E.

Industrial 'Carbon. *By* C. L. MANTELL, PH.D., *D. Van Nostrand Co., Inc., New York City. 410 pages, Illustrated. Price $4.50.*

As one of the Industrial Chemical Monographs, edited by W. L. Lewis and H. E. Howe, "Industrial Carbon" holds an important place in current technical literature. It is the second of this series of books dealing with subjects of importance to the chemist, and, more particularly, the chemical engineer. The first book of the group, "Fixation of Atmospheric Nitrogen," by F. A. Ernst, was reviewed on these pages some time ago, and six others on subjects varying from "Cracking of Petroleum," to "Chemistry of Candy Manufacture" are now in the process of preparation.

Elemental carbon is applied to mean those substances which consist of carbon as an element, or whose chief properties depend on the presence of carbon as a constituent. A surprising variety and number of important industrial commodities are technology's applications of elemental carbon, and the author tries to cover these uses, omitting the general and widespread use of carbon as a fuel.

Among the important forms of elemental carbon is that of the diamond. Although its use as a precious jewel is the one with which we are most familiar, the industrial uses of black diamonds and diamond dust are not to be overlooked. The diamond drill makes it possible to carry on important mining operations and obtain much of our supply of oil. As abrasives, they find application in the automobile industry, and their uses as dies for drawing fine wires and as a glazier's tool, are well known.

From diamond, the hardest material known, we go to graphite, one of the softest. This, too, is a form of elemental carbon, finding its chief applications as a lubricant, as an electrode material in electrochemical industries, for metallurgical crucibles, and in many minor fields.

Carbon black is employed in the manufacture of printer's inks. Since the developments of the automobile, however, it forms an essential ingredient in making pneumatic tires tougher and more resistant to wear.

These are but a few of the many uses of carbon which the author covers. He touches on its applications in pharmacy and lead pencils, as a resistor, and as a catalyst, in fact, in every conceivable way. The literature of the carbon industries is, at present, of rather recent development, but "Industrial Carbon" will serve as an excellent reference to those who are interested in the applications of this important element, in whatever field they may be.

H. S. G.

The National Air Races

(*Continued from page 175*)

"Prestone" cooled Hawk, followed by a successful parachute jump. Eric Hofman '27, test pilot for Keystone-Loening, B. Allison Gillies '27, Vice-President of Grover Loening Co., Dave Harrison '26 of Fairchild, J. C. Wilson '20 of Curtiss, Bob Purcell '27 of Alliance, Shepard Dudley '22 of Wright Aeronautical, Emil Chouré, who came East with the Navy "High Hat" Squadron, were the handful known to the writer among those who attended.

From all parts of the country, and from every branch of the industry, representatives came to the races. All types of planes were seen, varying in size from huge transport ships and bombers to the small one-place sport planes. The different events served to give evidence of the advantages of certain ideas and improvements in design, and it is to be hoped that at the National Air Races next year, the aviation industry will have a still more creditable record to show.

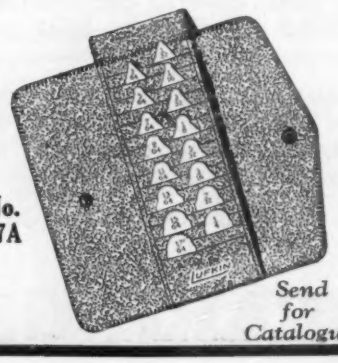
Prize Architecture

(*Continued from page 181*)

teacher of architecture to criticize their work. The work follows a plan made up by the Institute's committee on education. It will be interesting for Technology students to know that Professor Emerson, head of the department of architecture at M. I. T., served at one time as chairman of the committee on education. The Institute has grown so that it has groups of students all through the United States and Canada, and it is probably the largest school of its kind in the world.

Numerous incentives are offered in the form of various prizes; these have been offered to students of architecture in other schools as well.

Last year, Mr. W. C. Wurdeman, a graduate student in architecture, who came here from the University of Washington, at Seattle, placed in the Beaux Arts competition his project of an airport.



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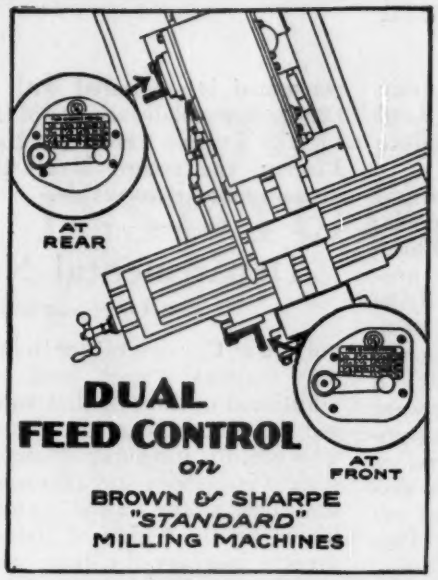

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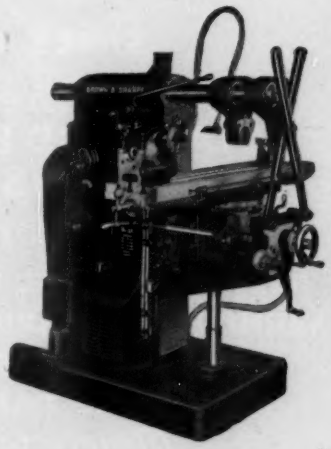

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The Seminole Oil Field

(*Continued from page 183*)

eet. Moreover, most of the wells were crooked, having been drilled just as rapidly as possible with rotary tools. Two wells, 660 feet apart at the surface, drilled into each other at a depth of 2,100 feet. The compression plants had to deliver a large volume of air or gas under high pressure to the wells.

To care for all the people engaged in this work, towns sprung up almost overnight — towns of wood and canvas with ungraded streets. Their appearance, to one acquainted with the boom mining camps of the West, was very familiar. But all this quickly changed to a more substantial construction, and a few months after the boom started streets were being paved, homes were being erected and a condition of law and order was more quietly maintained. Several companies erected complete modern camps for their employees.

In the preceding paragraphs, an attempt is made to show the amount of work necessary to bring an oil field into production. Due to our laws and the division of the land into small holdings in the Oklahoma fields, it is necessary to do the work quickly since the oil and gas belong to the person who can get them. If one person can drain the oil and gas from another's land through external wells, it is legal to do so.

The Seminole Field during the period of this narrative comprised four pools: namely, Seminole City, Bowlegs, Earlsboro and Searight with a total productive area of approximately 9,500 acres. In this area from July 16, 1926, the date of the discovery of oil in the Wilcox Sand, to November 1, 1927, a period of 15½ months, 1,100 wells were drilled and all the necessary equipment installed to care for the production of the oil, which at its peak was over 500,000 barrels per day, and extract the gasoline from the gas. This development cost $150,000,000.

As soon as a well was completed, its production was marketed or stored. During this period of 15½ months, the field produced 122,000,000 barrels of oil with a value at the well of $178,000,000. In addition to the above, the natural gasoline produced probably had a value, in the field, in excess of $7,000,000. This gives a total value to the products of $185,000,000.

When the magnitude of this development and the shortness of the time consumed is compared with some of the great metal discoveries of the world, such as Cripple Creek and the Alaska Placers, the record is all the more amazing and remarkable.

Departmental Notes

(*Continued from page 188*)

portion of Physics, rather than another, may emphasize such work by taking additional options in that subject during the fourth year. In this way men who are, for instance, attracted to the optical industries may take more optics, and those whose probable employment lies along the region of acoustics may greatly increase the time which they spend upon that subject. It is hoped that in this way a man's training may lie along the line in which his major interests are, with an increased satisfaction to the students and greater efficiency in their work.

Registration in Course VIII shows a satisfactory increase, to date the list showing twelve seniors, ten juniors, and seventeen sophomores, and a considerable number of graduate students.

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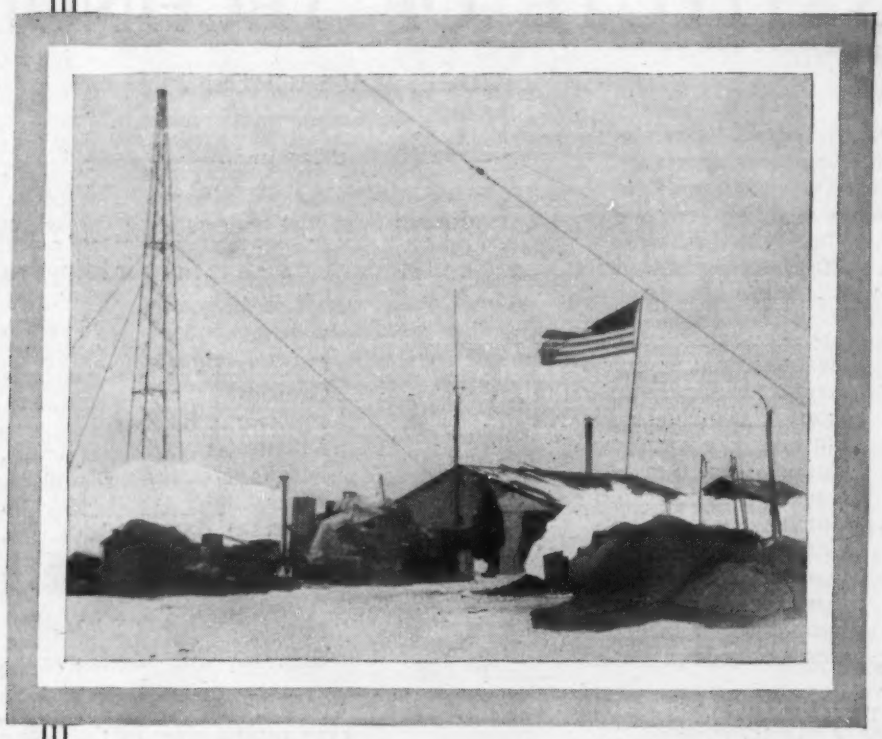
WHAT YOUNGER COLLEGE MEN ARE DOING WITH WESTINGHOUSE



The Base Station in Little America, where the Antarctic explorers spent the winter. (Photo copyright 1929 by the New York Times Company and the St. Louis Post Dispatch)

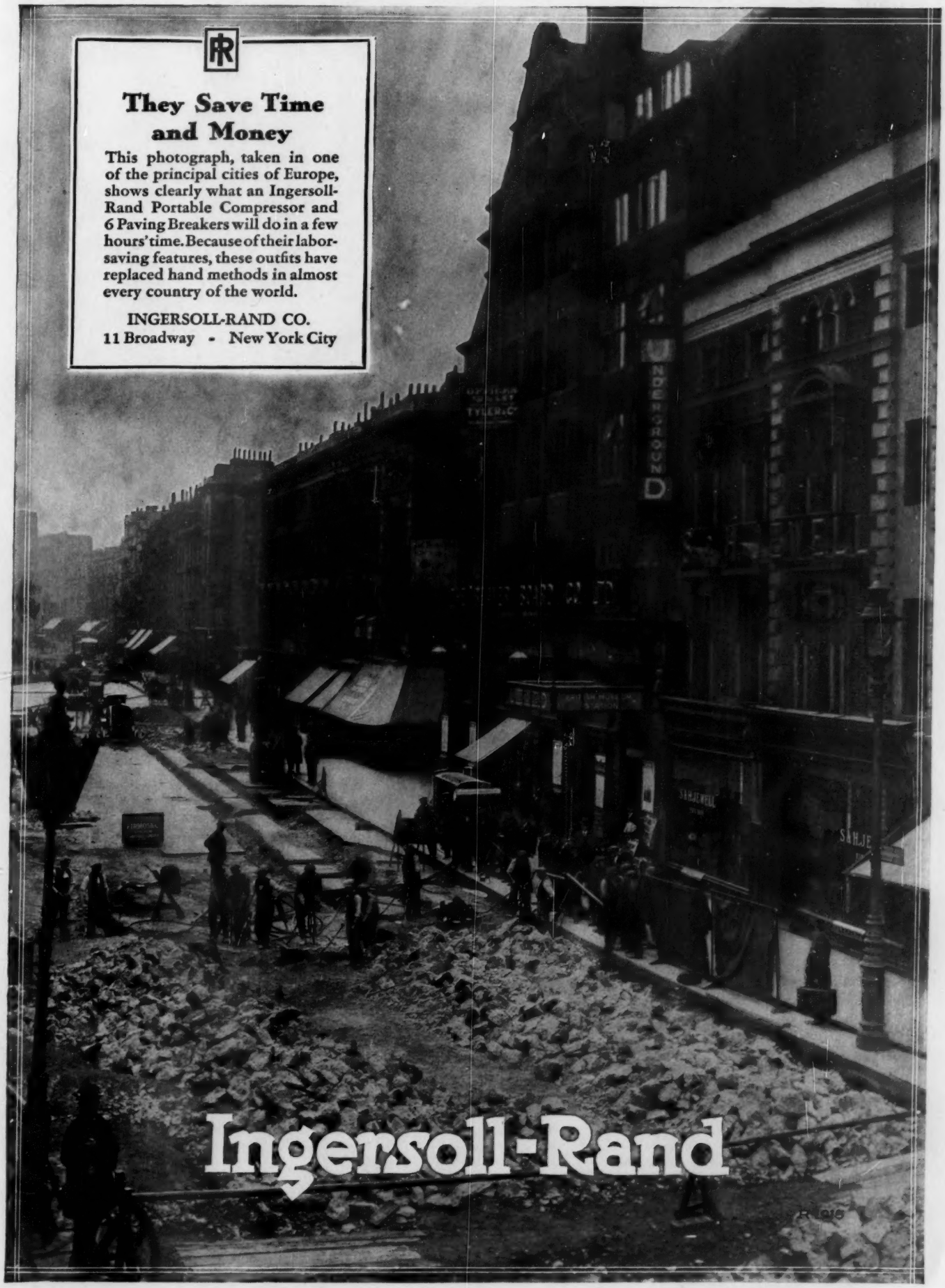
The radio that's heard at the bottom of the world

Six months of night did not mean dreary isolation for Commander Byrd's hand-picked band of Antarctic explorers. Fortnightly the Westinghouse short-wave radio station in East Pittsburgh sent them programs of music and cheer and word from their families. Between scheduled programs it lent a helping hand in sending down interesting bits of news, relaying messages for other stations that couldn't get through, and even completing connections between the "Eleanor Bolling" and Byrd's Base Station when they did not hear each other.

Spectacular feats have been achieved by the Westinghouse men working on short-wave radio research, in reception as well as sending. An average of five nights a week they bring in 5 S W of Chelmsford, England, and re-broadcast to America the midnight chimes of Big Ben. Strange voices from Holland, Australia and far off Java and the Fiji Islands register on their receivers quite as faithfully as a station a thousand miles distant comes in on the average set. Many stations in remote corners of the world depend on their broadcasts for entertainment and up-to-the-minute news.

Young college men figure prominently in the exploration for new possibilities in radio communication. Their field is rich in opportunity — their facilities are the finest that modern science affords.

Westinghouse


They Save Time and Money
This photograph, taken in one of the principal cities of Europe, shows clearly what an Ingersoll-Rand Portable Compressor and 6 Paving Breakers will do in a few hours' time. Because of their labor-saving features, these outfits have replaced hand methods in almost every country of the world.
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From an engraving of the time in Harper's Weekly

Autumn of '79

WHILE Yale and Princeton were battling to a tie at Hoboken, New Jersey, a small group of scientists, directed by Thomas A. Edison, was busy at Menlo Park, only a few miles away. On October 21, their work resulted in the first practical incandescent lamp.

Few realized what fifty years would mean to both electric lighting and football. The handful who watched Yale and Princeton then has grown to tens of thousands to-day. And the lamp that glowed for forty hours in Edison's little laboratory made possible to-day's billions of candle power of electric light. In honor of the pioneer achievement, and of lighting progress, the nation this year observes Light's Golden Jubilee.

Much of this progress in lighting has been the achievement of college-trained men employed by General Electric.

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